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THE PROBOSCIDIA.

BY E. D. COPE.

THE Proboscidia are Ungulata in which the second row of carpal bones has not moved inwards so as to alternate with the first, and in which the second row of tarsal bones alternates with the first by the navicular extending over part of the proximal face of the cuboid. The teeth are modifications of the quadritubercular type, and canines are absent.

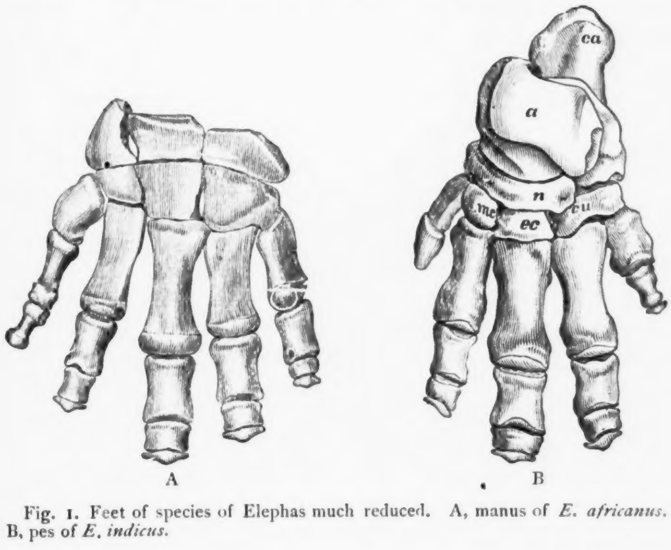


Fig. 1. Feet of species of Elephas much reduced. A, manus of *E. africanus*. B, pes of *E. indicus*.

To these general characters are added numerous subordinate peculiarities in the known genera and species, which make them among the most remarkable of living beings. These peculiarities are the result of a long period of development. It is one of the most curious facts of paleontology that the order does not make its appearance until the middle of the Miocene system, and the greater number of forms do not appear until the upper Miocene. That it existed earlier cannot be doubted, and that it originated from some Eocene condylarthran is evident ; but the intermediate forms are entirely lost to us as yet, and the phylogeny of the order is absolutely unknown. This is the more extraordinary since the earliest known genus (Dinotherium) embraces only species of colossal size, and its immediate ancestors could not have been insignificant. We may regard Phenacodus as the first form we know of earlier than Dinotherium, but what a hiatus is expressed in this statement ! It is to be anticipated that the gap will be filled by discoveries in Asia, or the Southern Hemisphere. South America may be probably excluded from this prospect, since the extensive researches made there by Burmeister, Ameghino, and Moreno, have not resulted in the discovery of any Proboscidia earlier than the Pliocene. Asiatic investigations have revealed nothing, as the proper formations have not been found, and the same is true of Africa. So we shall have to wait until the paleontology of the present home of the order is exposed to view, before we shall know of the steps which lead from Phenacodus to these mighty monarchs of the animal kingdom. The absence of primitive Proboscidia from North and South America and Europe, impels us to believe that the representatives of the order known to us from those regions, are the descendants of immigrants from Asia and Africa.

But two families of Proboscidia are known. They are defined as follows :

Adult dentition embracing premolars and molars ; no superior incisors.................................*Dinotheriidæ*.

Adult dentition embracing one or two true molars only ; superior incisors.................................*Elephantidæ*.

The family of the Dinotheriidæ embraces one genus and

four species, though a fifth species, *D. sindiense* Lyd., from India, may belong, according to Lydekker, to another genus. The *Dinotherium indicum* Falc. is known from a few teeth, which exceed in size those of the other species. The *D. giganteum* Kaup is found in several Miocene deposits of Europe. It was one of the largest of Mammalia, its femur exceeding in dimensions that of any other land mammal. The inferior incisors were robust and cylindric in form. With the symphysis of the lower jaw they are decurved so as to form a most effective instrument for the tearing up of trees by the roots, or the pulling down of their branches The temporal fossa is lateral, and the top of the head flat. The premaxillary region though toothless, is prominent, and the nasal bones do not project. There is supposed to have been a short trunk. The skull measures three feet eight inches in length. (Plate XV.)

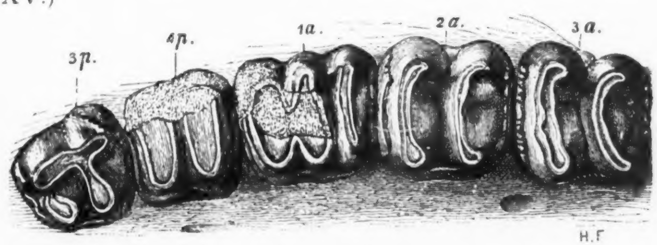


Fig. 2. *Dinotherium giganteum* Cuv. left superior molars, one fourth nat. size. From the Miocene of France. From Gaudry.

Two smaller species are known, the *D. bavaricum* from European, and *D. pentapotamiæ* from Indian Miocene beds.

In Dinotherium all the molars and premolars have two transverse crests excepting the first (posterior) premolar, and its deciduous predecessor, which have three cross-crests.

The genera of the Elephantidæ are the following :

I. Inferior incisors and premolars present.

Superior incisors with enamel-band........................ *Tetrabelodon* Cope.

II. Premolars, but normally no inferior incisors ;

Intermediate molars isomerous ; superior incisors with enamel-band.
Dibelodon Cope.

Intermediate molars isomerous superior incisors without enamel-band.
Mastodon Cuv.

Intermediate molars heteromerous; superior incisors without enamel-band.
Emmenodon Cope.[1]

III. No premolars, nor inferior incisors.

Intermediate molars heteromerous. Superior incisors without enamel-band.
Elephas Linn.

The characters assigned to the above genera are sufficient to separate them, but they have not come into general use for two reasons. One is the difficulty of verifying some of them, especially the presence of premolars, owing to the difficulty of obtaining specimens of young individuals. The other is the indisposition of naturalists to abandon the system of Falconer. As is well-known, this able paleontologist distinguished the genera by the number and depth of the transverse crests of the molar teeth, and the extent to which their interspaces are filled with cementum. This arrangement is insufficient, since it neglects the equally important characters above

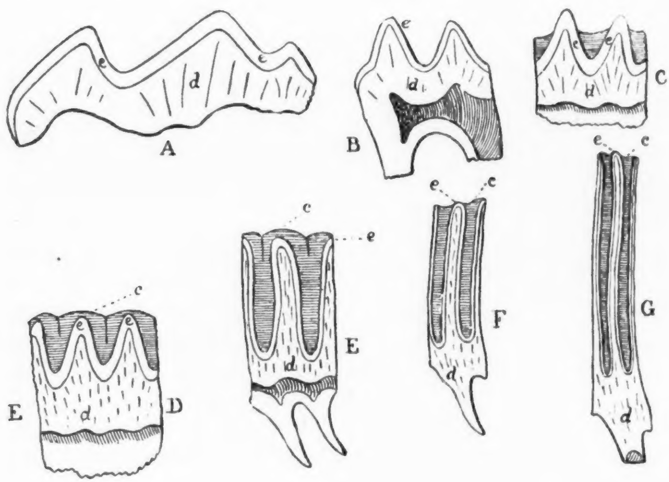


FIG. 3. Longitudinal sections of the molar teeth of Proboscidia, much reduced, from Gaudry. Letters; *c* cementum; *d* dentine; *e* enamel. A, Inferior molar of *Dinotherium giganteum* Cuv. B, superior molar of *Mastodon americanus* Cuv. C, lower molar of *Elephas ganesa* C..F. D, do. of *Elephas insignis* C. F. E, do. of *Emmenodon planifrons* C. F. F, do. of *Elephas hysudricus* C. F. G, do. of *Elephas indicus* L.

[1]Gen. nov. Type *Elephas cliftii* Falc. Cautl., *Mastodon elephantoides* Clift.

PLATE IX.

Tetrabelodon campester Cope.

mentioned ; and as observed by Lydekker[1] it fails to furnish clear definitions. He remarks, under the head of the genus Elephas, "There is no character by which the present genus can be distinguished from Mastodon ; and the division can be therefore only regarded as a matter of convenience." The characters presented in the above table are on the other hand very distinctive, and can be applied in all cases where we have the necessary information. This has not yet been obtained as regards all the species, and I have placed some of them in their respective genera provisionally. Such species are marked with an *i* when the condition of the incisors is unknown, and with a *p* when the same is true of the premolars. The species of the family described thus far, are as follows :

Tetrabelodon brevidens[3] Cope sp. nov. N. America *i. p.*
" *turicensis* Schinz. Europe.
" *angustidens* Cuv. Europe.
" " *palæindicus* Lyd. India.
" " *proavus* Cope. N. America.
" *productus* Cope. N. America, ? Mexico.
" *euhypodon* Cope. N. America *p.*
" *pandionis* Falc. Cautl. India.
" *pentelici* Gaudry.[4] Europe *p.*
" *campester* Cope. N. America. *p.*
" *longirostris* Kaup. Europe.
" *? serridens* Cope. Texas ?Mexico ?Florida.[5] *i. p.*
Dibelodon shepardi Leidy. California, Mexico. *p.*
" *cordillerarum*[6] Desm. South America.
" *tropicus* Cope. South America and Mexico. *p.*
" *humboldtii* Cuv. S. America.
Mastodon americanus Cuv.[7] N. America.
" *borsoni* Hays. *p.* Europe.
" *falconeri* Lydd. India. *p.*

[1]Catalogue of fossil Mammalia in the British Museum Pt. IV. p. 79.

[2]In compiling this list I have been greatly aided by the Memoirs of Lydekker in the Palæontologia Indica, and in the Catalogue of the British Museum.

[3]*M. proavus* Cope 1884 not 1873.

[4]According to Lydekker no premolars have been seen in this species.

[5]*M. ?floridanus* Leidy.

[6]*M. andium* Cuv. According to the recent researches of Burmeister, this species does not possess mandibular tusks. (Sitzungsb. Kön. Preuss. Akad. Wiss. Berlin 1888 p. 717.) Hence the specimens from Mexico with such tusks reported by Falconer, must be assigned elsewhere.

[7]This species is said by Lydekker not to possess premolars. Leidy Report U. S. Geol. Surv. Terrs. Pl., figures a tooth as a premolar, and similar specimens are not uncommon.

Mastodon *mirificus* Leidy. N. America. *i. p.*
" *sivalensis*[1] Cautley. India. *p.*
" *arvernensis* C. & J. Europe.
" *?punjabiensis* Lydd. India. *p.*
" *latidens* Clift. India.
Emmenodon elephantoides[2] Clift. India to Japan.
" *planifrons* Falc. Cautl. India.
Elephas bombifrons Falc. Cautl. India, ? China.
" *ganesa* Falc. Cautl. India.
" *insignis* Falc. Cautl. India to Japan.
" *meridionalis* Nesti. Middle and S. Europe, and N. Africa.
" *hysudricus* Falc. Cautl. India.
" *antiquus* Falc. Europe ? W. Africa.
" *mnaidriensis* Leith-Adams. Malta.
" *melitensis* Falc. Malta.
" *namadicus* Falc. Cautl. India to Japan.
" *primigenius columbi* Falc. W. N. America, Mexico.
" " *primigenius* Blum. N. Hemisphere.
" " *americanus* DeKay. E. N. America.

To these we must add the two existing species, *Elephas africanus* and *E. indicus*. Several species are not sufficiently known for reference to their proper genus. Such are *Mastodon perimensis* Falc.Cautl. India ; *M. atticus* Wagn. S. Europe ; *M. serridens* Cope, Texas ; *M. cautleyi*, Lydd. India, and *M. obscurus* Leidy, N. America. In these the characters of both the incisor and premolar teeth are unknown. In some

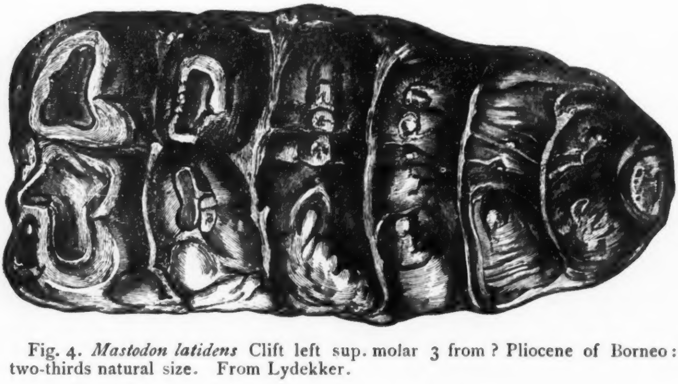


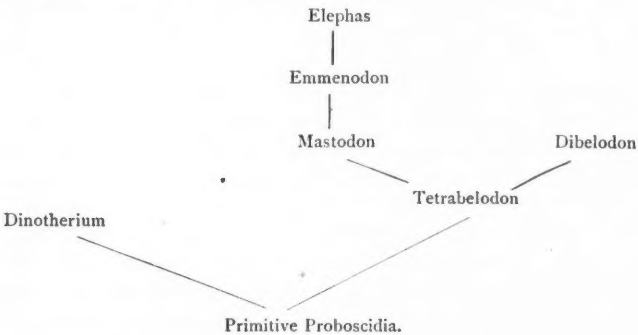
Fig. 4. *Mastodon latidens* Clift left sup. molar 3 from ? Pliocene of Borneo: two-thirds natural size. From Lydekker.

[1]According to Lydekker, premolars have not been observed.
[2]*Mastodon* Clift ; *Stegodon* Falconer ; *Elephas* Lydekker.

of the species referred above to Mastodon, mandibular tusks are present in the young, and occasionally one is retained to maturity, as sometimes seen in *M. americanus*. But such individuals are exceptional among their species. In some other species while the males possess them, they are wanting to the females. The specific character is in this case derived from the male.

The molar dentition in this family possesses a number of peculiarities which have been worked out mainly by Falconer, Owen, and Lydekker. There are probably deciduous molars in all the species, and they are generally three in number. The posterior of these has the same number of cross-crests as the posterior premolar, which immediately succeeds it. The number of crests diminishes to the first of the series. There are two or three premolars in most forms of the family, but in the genus Elephas they have disappeared. In all the species they are shed early in life in order to make way for the true molars. As the latter teeth are very large, and the fore and aft extent of the jaws is small, there is only space for one or two of them at a time. In most of the species the last molar so much exceeds the others in size, that it occupies the entire jaw, and the other molars are shed in order to accommodate it. In the genera Tetrabelodon, Dibelodon, and Mastodon, the last premolar, and the first and second true molars are isomerous, *i. e.* have the same number of cross-crests. In Emmenodon and Elephas they are heteromerous; that is, the number of cross-crests successively increases from front to rear. Thus in the three genera named the ridge formula is; P. M. 2—2—3; M. 3—3—4, and P. M. ?—? 4; M. 4—4—5 or 4—5—6. In Emmenodon the ridge formula is, P. M. ?—?—?—5; M. 6-7—6—7-8; and P. M. ?—6-7; M. 7—8-9—10-12. In Elephas the formula extends from M. 6—6-7—8-9, to M. 9-15—14-16—18-27. Each genus then has a certain range of variation in the number of molar crests, extending from a smaller to a larger number. This successive increase in complexity has been regarded by Falconer as the index to the successive evolution of the species, and rightly so. As already remarked, however, other measures of the same succession cannot be overlooked, especially as

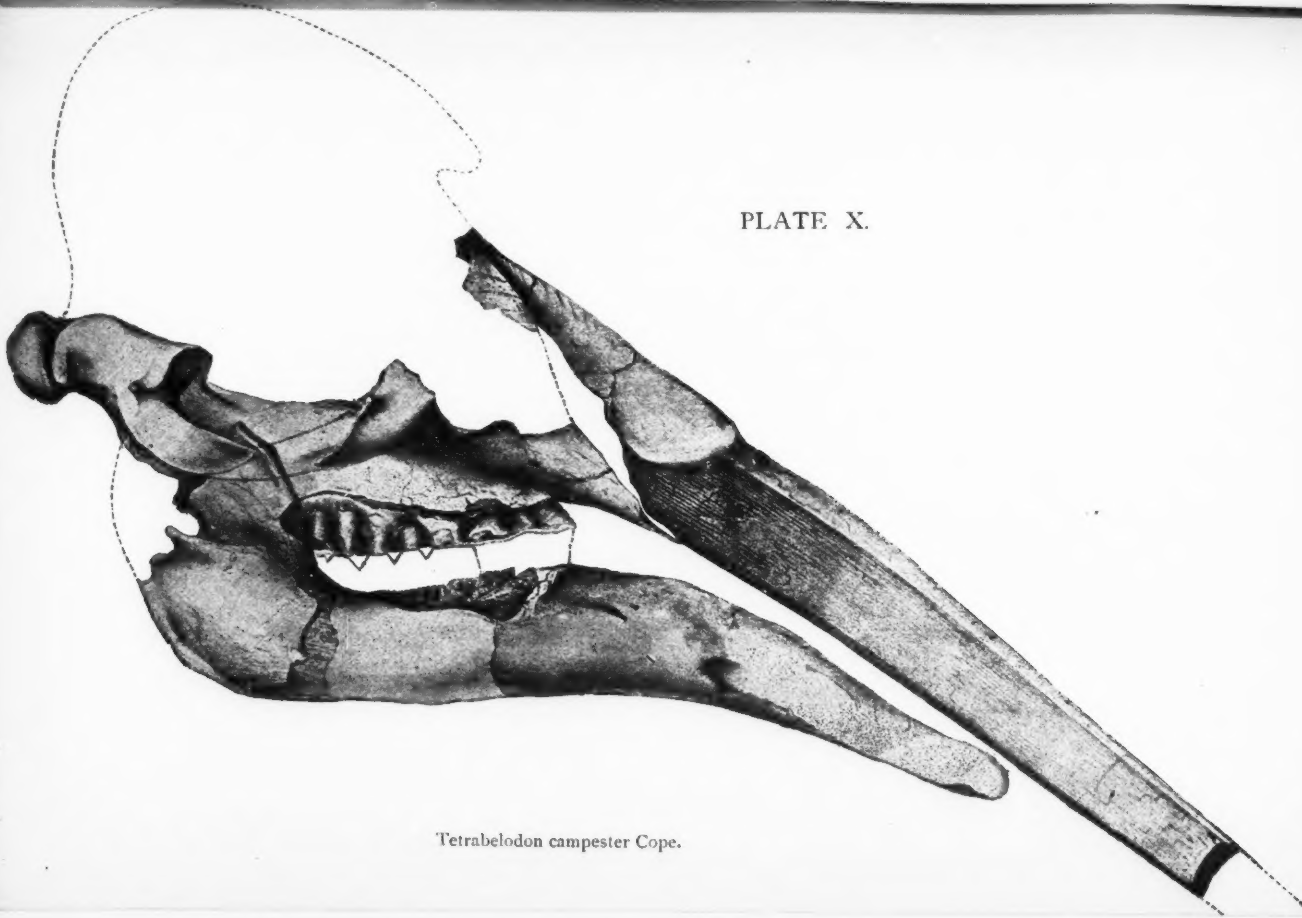
the ridge formula changes in so gradual a manner as to render it unavailable as a basis of exact divisions, as has been remarked already by Lydekker. It is evident that the primitive Proboscidia had incisor teeth in both jaws, and that these had more or less of the usual enamel investment. The gradual modification of these features is therefore another indication of the line of descent of these animals. The primitive Proboscidia had likewise four premolars, as is now seen in Dinotherium. The successive loss of these teeth is no less an index of the evolution of the modern types of the order, than the other modifications referred to. In general, then, the phylogeny of the order may be represented thus :



Within each genus certain parallel modifications of the composition of the crowns of the molar teeth may be observed. The cross-crests may be single, or they may be divided up into tubercles. The valleys between them may be open (1) or they may be blocked by (2) a system of single intermediate tubercles ; (3) by numerous intermediate tubercles ; or (4) by the thickening of the primary tubercles. I arrange the species according to these characters.

	Tetrabelodon.	Dibelodon.	Mastodon.
1	*T. ? brevidens.*		*M. americanus.*
	T. turicensis.		*M. borsoni.*
			M. latidens.
2	*T. angustidens.*	*D. shepardi.*	*M. ? cautleyi.*
	T. productus.	*D. cordillerarum.*	*M. falconeri.*
	T. serridens.	*D. tropicus.*	

PLATE X.



Tetrabelodon campester Cope.

	T. euhypodon.		*M. arvernensis.*
	T. longirostris.		
3	*T. campester.*	*D. humboldtii.*	*M. sivalensis.*
	T. pandionis.		*M. punjabiensis.*
4			*M. mirificus.*
			?M. atticus.

Parallels between the species of Emmenodon and Elephas also exist. As but two species of the former genus are known, we must look for future discoveries to increase the number of correspondences. The species of both genera which approach nearest to Mastodon have a smaller number of cross-crests, which are of lesser elevation, and whose intervening valleys are occupied by but a shallow deposit of cementum (fig. 3, C. D.) These are the Stegodons of Falconer; (1). In the other group, (2) the crests are numerous and elevated, and their interspaces are filled with cementum. (Fig. 3, E. F.)

	Emmenodon.	Elephas.
1	*E. elephantoides.*	*E. bombifrons.*
		E. ganesa.
		E. insignis.
2	*E. planifrons.*	*E. meridionalis.*
		E. hysudricus.
		E. antiquus. etc.

It is observable that each type of molar teeth of the three genera first compared, has representatives in the regions where their species occur ; North America, Europe and India.

The North American species of this family are distinguished by the following characters of the molar teeth.[1]

I. Intermediate molars with not more than three crests ; (trilophodont).

a. Crests acute, transverse.

β. Valleys uninterrupted.

Last superior molar with three crests and a heel ; crests low, not serrate. *T. brevidens.*

Last superior molar with four crests and a heel ; crests elevated, not serrate. *M. americanus.*

ββ. Valleys interrupted.

[1]From the AMERICAN NATURALIST. 1884. p. 524.

Edge of crest tuberculate..*T. serridens.*

aa. Crests transverse, composed of conic lobes.

β. Valleys little uninterrupted.

Last inferior molar narrow, with four crests; an accessory tubercle in each valley; *D. shepardi.*

β. Valleys interrupted.

Last inferior molar with four crests and a heel; symphysis short, M. 150; smaller size..*T. euhypodon.*

Last inferior molar with four crests and a cingulum; symphysis longer, M. .280; size medium..*T. productus.*

Last inferior molar with five crests and a heel; symphysis very long, M. .450; size largest..*T. angustidens.*

"*aaa.* Crests broken into conic lobes; those of opposite sides alternating.

Last inferior molar narrow, supporting four crests and a heel.......*T. obscurus.*"

II. Intermediate molars with four transverse crests; (tetralophodont).

A long symphysis; crests well separated, tubercular, with accessory lobes interrupting valleys..*T. campester.*

Symphysis very short; crests thick, closing valleys by contact; no accessory cusps; (Leidy)..*M. mirificus.*

III. Intermediate molars with 9–16 crests.

β. Valleys filled with cementum.

Last molar with 18–27 cross-crests; ....*Elephas primigenius.*

The stratigraphic position of these species is as follows:

Pleistocene.
 Mastodon americanus.
 Elephas primigenius (less abundant).

Pliocene.
 Elephas primigenius (more abundant).
 Tetrabelodon serridens (horizon probable).
 Dibelodon shepardi.

Upper Miocene (Loup Fork).
 Tetrabelodon euhypodon.
 " *productus.*
 " *angustidens.*
 " *campester.*
 Mastodon mirificus.

Ticholeptus bed.
 Tetrabelodon brevidens.

The horizons from which were obtained the *Tetrabelodon obscurus* Leidy and the *Dibelodon shepardi* Leidy, are not sufficiently well-known. In the valley of Mexico, the *D. shepardi* is from the Pliocene. No species of the order has been found below the Ticholeptus beds; a horizon about parallel

with that in which the order first appears in Europe. The statement of Marsh that the genus has been obtained in the lower White River beds is an error. (King, Survey 40th parallel, I p. 412.)

The *Tetrabelodon brevidens* Cope is the oldest North American species, and presents a very simple type of molar. The last superior has but three cross-crests and a heel, a smaller number than exists in any other species of the genus. The tooth is wide, and the crests are low. They are well divided in the middle by a fissure. Their edges are entire, but obtuse, and the first and second internal have a thickening at the base next the median fissure, which wears into a trefoil. These thickenings close the valleys at their base, but soon spread apart. They are absent from the third crest. The valleys are bounded on the inner side by a well defined ledge, which is represented by a rudiment on the external side. Enamel thick and smooth. Length of molar, 157 mm.; width at second crest, 98 mm.; elevation of second crest, 54 mm. This tooth resembles that of the *Mastodon americanus* more nearly than that of any other North American species, and is still more like that of the *M. borsoni* of Europe. The reduced number of its crests indicates it as the most primitive

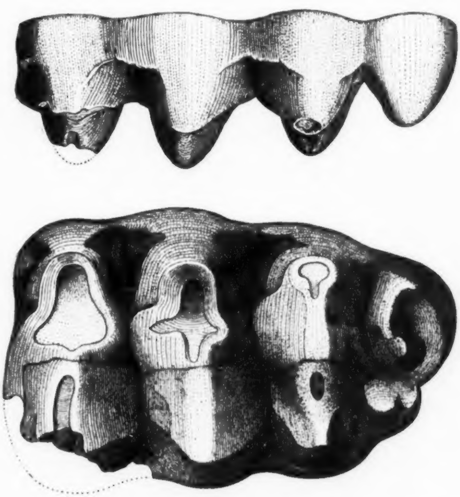


FIG. 5. *Tetrabelodon brevidens* Cope; last superior molar; from Ticholeptus bed of Montana. Four-ninths natural size. Original.

of the elephants, and as its horizon is the oldest, I have suspected that it had well developed incisor teeth in the lower jaw, and have, therefore, placed it provisionally in the genus Tetrabelodon. It is probably ancestral to the *M. americanus*, but, perhaps, not through American forms, since none with the same type of molar have been yet found in the formations which intervene between those in which the two species occur. Such forms occur in Europe, as the *Tetrabelodon turicensis* and the *Mastodon borsoni*. Unless some species of synchronous age with these is found in North America, we may suppose that the *Mastodon americanus* derived its immediate descent from Asiatic and European forms.

With the *Tetrabelodon angustidens* Cuv. we commence the series in which the transverse crests of the molars have the appearance of being composed of distinct but appressed conic tubercles. In most of them, the valleys are more or less interrupted by tubercles. This is one of the most abundant,

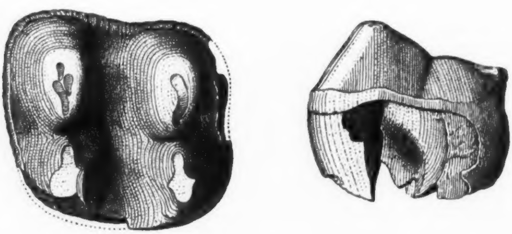
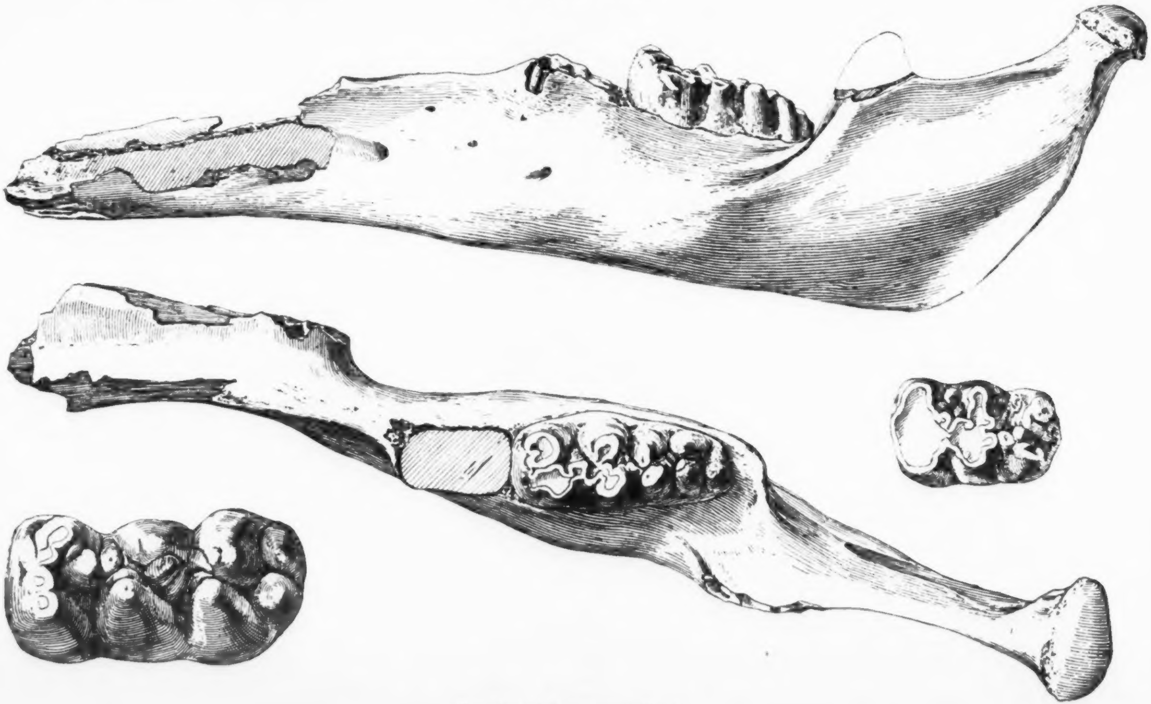


FIG. 6. *Tetrabelodon angustidens proavus* Cope; typical specimen from the Loup Fork bed of Colorado, two-thirds natural size. Original.

as well as the most widely distributed species of the family, extending its range from India to Central North America, through Europe. I have seen specimens from the Loup Fork beds of Kansas, Nebraska, and Dakota. Their size exceeds those of the typical European form, and the second (and probably third) true molars have a narrow fourth cross-crest. It is possible that it may become necessary, with more complete information, to distinguish this form as a species

PLATE XI.



Tetrabelodon proavus Cope.

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under the name of *Tetrabelodon proavus.*[1] Probably, the same species has been recorded by Whitfield, from the phosphate beds of South Carolina, and compared with *M. obscurus*. The skeleton of the European form is represented in Plate XII. In a lower jaw in my possession, the left ramus measures m. 1.080 in length, of which .420 is symphysis.

The *Tetrabelodon euhypodon* Cope was founded on a nearly perfect left mandibular ramus with last molar tooth and tusk,

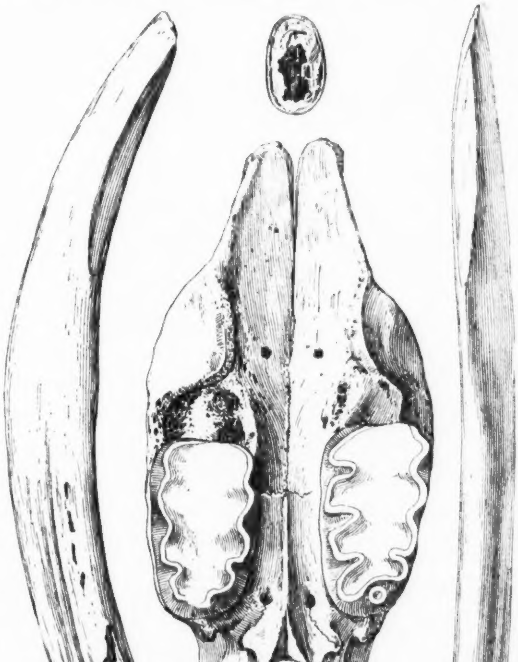


FIG. 7. *Tetrabelodon euhypodon* Cope; Loup Fork bed of Kansas. Palate with superior molars and superior incisors, of individual represented in Plate XIII; one-seventh natural size. Original.

[1] This species was originally represented by a penultimate milk molar, with two cross-crests, and the fragments of a probable last premolar. The former is about the size of that of the *M. angustidens*, but is more regularly quadrangular, and is composed of but four tubercles, united in pairs. (Fig. 6.)

with entire palate with both last molar teeth and tusks. The superior tusks are compressed distally, and the inferior tusks are large and have an enamel band ; they are cylindric. The jaws indicate a smaller species, but the molar teeth are as large as those of the larger American form of *M. angustidens*, and as long as that of *M. americanus*, but narrower. Its symphysis is not prolonged, and the ramus is low and not compressed. Length of ramus posterior to symphysis, M. .500 ; of last lower molar, .182 ; width of do., 75. The mental tusk is much larger than that of *M. productus* or *M. angustidens*. Diameter of its alveolus, .068. There are several marked peculiarities in this species. The symphysis is remarkably short, when we consider the large size of the inferior tusks. The superior tusks are remarkably compressed for a considerable part of their length distally, having a vertically oval section. From the Loup Fork bed of Kansas.

Tetrabelodon productus Cope is abundant in the Loup Fork beds of New Mexico. It is a species of about the dimensions of the *T. angustidens* Cuv., but the symphysis is not so produced, and the ramus of the lower jaw is not compressed and elevated. It is the only species in which three superior premolars have been demonstrated; other species having generally two. The second and third true molars are in use at one time.

Tetrabelodon campester Cope is a rather large species, with a very long symphysis of the lower jaw, and a low ramus. The teeth are tetralophodont, and the sixth molar has six cross rows of tubercles and a heel. It is in some measure allied to the *T. longirostris* of Europe, but the symphysis is longer, and the teeth are more complex. The tusks are cylindric and nearly straight, and have a wide band of enamel. The known specimens are from the Loup Fork beds of Kansas and Nebraska. (Plates IX, X.)

The *Dibelodon shepardi* Leidy was founded on an inferior sixth molar tooth from California. I subsequently[1] described specimens of the same from the Pliocene bed of the valley of Mexico, where it was abundant. The molar teeth are rather

[1] "Proceed. Amer. Philosoph. Society," 1884, p. 5.

simple in construction, and resemble those of the *D. cordillerarum* Desm., but the species has a short, elephant-like symphysis.

The *Tetrabelodon serridens* Cope was founded on a first or

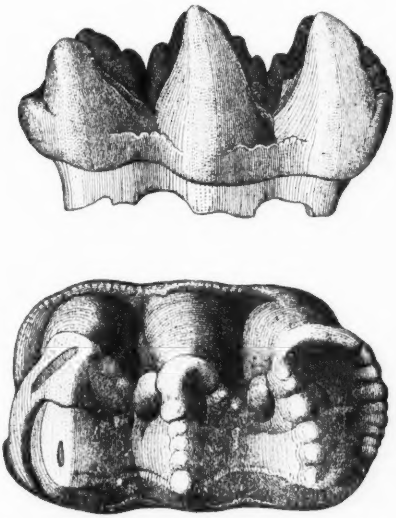


FIG. 8. *Tetrabelodon serridens* Cope; ?first molar. Typical specimen from ?Pliocene of Texas. Four-ninths natural size. Original.

second true molar from Texas. It is peculiar among American species in its acute elevated, entire crests, with tuberculo-serrate edges. It thus resembles the *M. turicensis*, but differs in well-developed longitudinal crests at the inner end of the external half of the crests, which consist of two tubercles on the posterior side of a crest, and one on the anterior side of the next succeeding crest. Strong anterior and posterior cingula ; edge of each cross-crest with six or seven tubercles. Length of crown, M. .130 ; width, .080 ; elevation, .061 Length of *M. americanus*, but narrower. Remains of a large Tetrabelodon from Florida have been described by Leidy under the name of *T. floridanus*. Its molars present

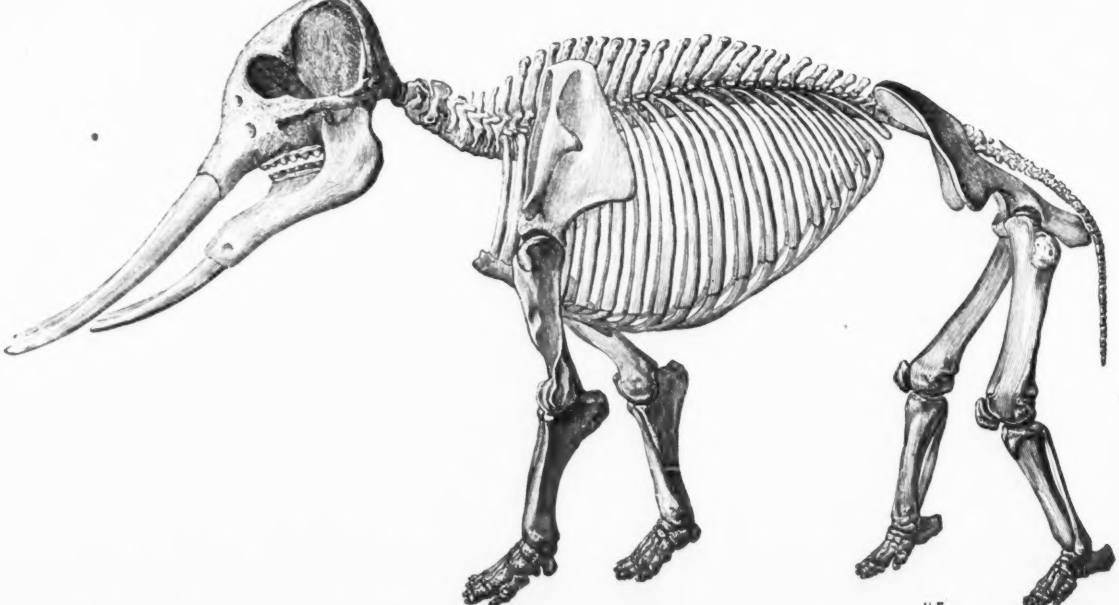
the tuberculated crests of the *T. serridens*, and no important characters appear to separate it from the latter.

The *Mastodon mirificus* Leidy is known from a left ramus of a lower jaw, which supports the last molar. The intermediate molars are probably four-crested (tetralophodont), and the last molar has six crests, and is a large tooth, occupying the entire dentary portion of the lower jaw. In this respect it differs from the *Tetrabelodons campester* and *longirostris*, where the fifth and sixth molars are in simultaneous use. The crests are divided on the middle line, and each half is so expanded as to close the intervening valleys very early in wear. Its symphysis is short and acute. Its nearest ally is the *M. atticus* Wagner, from the Upper Miocene beds of Pentelicus, Greece.

Mastodon americanus Cuv. is the best known and latest in time of the American elephants. It is one of the largest species, and, after *T. brevidens*, possesses the simplest molar dentition. The symphysis of the lower jaw is short and decurved. The skull is wider and less elevated than that of the mammoth, and the tusks are shorter and less recurved. It was very abundant during the Plistocene age throughout North America, from ocean to ocean, and as far south as Mexico; but it has not been found in the latter country. Its remains are usually found in swamps, in company with recent species of Mammalia, and with *Equus fraternus* and *Bos latifrons*. The carbonaceous remains of its vegetable food have been found between its ribs, showing that, like the mammoth, it lived on the twigs and leaves of trees.

It is at first sight curious that this, the simplest of the family of elephants in the characters of its molar teeth, appears latest in time on this continent. But it must be regarded as an immigrant from the Old World, where an appropriate genealogy may be traced. Its nearest ally, *Mastodon borsonii*, existed just anterior to it, during the Middle and Upper Pliocene, and this species was preceded in turn in the Middle and Upper Miocene by the *T. turicensis*, which possesses the same simplicity of the molar teeth. In its mandibular tusks the latter possesses another primitive character, which was nearly lost by its North American descendant.

PLATE XII.



Tetrabelodon augustidens Cuv.   From Gaudry.

An ingeniously constructed fraud, consisting of parts of molar teeth of this species fastened together by cement, which was treated with wax, so as to resemble enamel, was described by me as representing a distinct species of this order, under the name of *Cænobasileus tremontigerus*.[1] The specimen was manufactured in southwestern Texas.

Elephas primigenius Blumenbach, the mammoth, was at one time distributed throughout North America, as far south as the valley of Mexico, inclusive. Its remains are found in the Upper Pliocene of Oregon, and in the Pliocene of Mexico, unaccompanied by the *Mastodon americanus*, which had not appeared by that time. In the Eastern States its remains occur with those of the *Mastodon americanus* at the Big Bone Lick, in Kentucky. It was not found in the Port Kennedy, Pennsylvania, Bone-fissure, although the Mastodon was there. This absence may have been accidental. Says Leidy[2]: "The animal (*Elephas primigenius americanus*) was probably of earlier origin, and became earlier extinct than the latter," an opinion which my own observations confirm. Since no earlier species of elephant proper is known from North or South America, we must regard this one as an immigrant from Asia, where, indeed, its remains abound. It remained longer in Siberia than in North America, since whole carcasses have been discovered imprisoned in the ice, near the mouth of the Lena River. These specimens had a covering of long hair, with an under hair of close wool.

Leidy and Falconer have observed that the teeth of the elephants from Eastern North America can be easily distinguished from those of the Mammoth by the greater attenuation of the enamel plates. Leidy also observes that the lower jaw is more acuminate in the former. He proposed, therefore, to distinguish it as a species, using Dekay's name, *E. americanus*. Teeth from Escholtz Bay, Alaska, he regards as belonging to the true *E. primigenius*.

Falconer regarded the true elephant of Texas as a distinct species, which he named *E. columbi*. He distinguished it by the coarse plates of the enamel, and by the wide lower jaw,

[1] "Proceedings American Philos. Society," 1877, p. 584.

[2] "Extinct Mammalia of Dakota and Nebraska," p. 398.

with curved rami, and short symphysis. So far as the dentition goes, I have specimens of this type from Colorado and from Oregon. The Oregon specimen presents the same type of lower jaw as does one from Texas, in my possession. Specimens from the valley of Mexico are abundant in the museums of the City of Mexico, and their characters do not differ

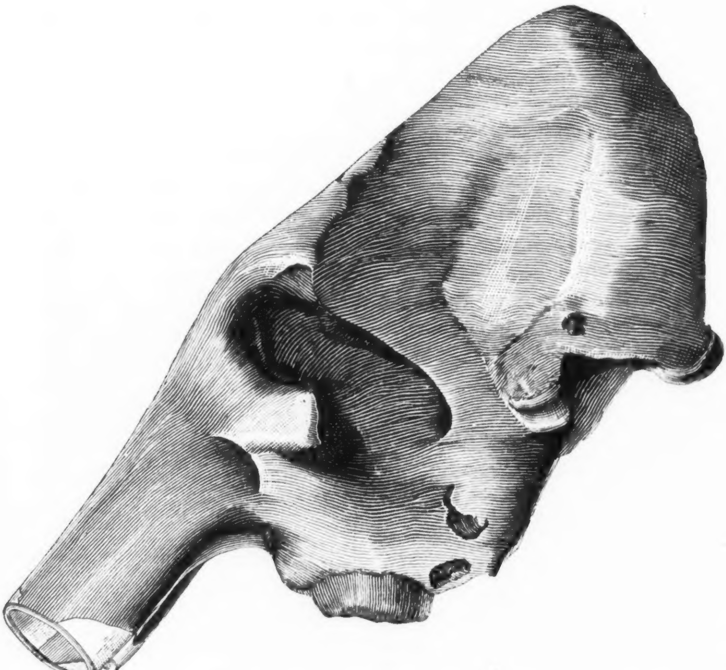


FIG. 9. ***Elephas primigenius columbi*** **Falc., from Texas. Natural size. Original. Profile of skull represented in Plate XIV.**

from those from Texas. I have in my museum an entire skull, lacking the lower jaw, (Plate XIV.), from the "orange sand" of the city of Dallas, in Northeastern Texas, which only differs in form from that of the *E. primigenius*, as figured by Blumenbach and Cuvier, in the shorter and wider premaxillary region. This is one-half wider than long (from the molar alveolus)

while in the Ilford Mammoth in the British Museum, figured by Leith Adams,[1] the length of this region equals the width. The skull agrees with those of the *E. primigenius*, and differs from those of the *E. indicus* in the narrower proportions of the posterior part of the cranium. The teeth are of the coarse-plated *E. columbi* type. The individual is not very large, though old. The diameter of the tusks at the alveolus is 110 mm. In a fragment of a huge specimen from Southwestern Texas, the diameter of the tusk at the base is 210 mm.

As a result, it is not clear that the two American forms can be distinguished as yet from the *Elephas primigenius* or from each other, except as probable subspecies, *E. p. columbi*, and *E. p. americanus*. But more perfect material than we now possess may yet enable us to distinguish one or both of these more satisfactorily. No American species of the family exceeded this one in general dimensions, especially the form *E. p. columbi*.

EXPLANATION OF PLATES.

Plate IX.

Tetrabelodon campester Cope. Palate with teeth from below, one-fourth natural size; from Loup Fork bed of Kansas. Original.

Plate X.

Side view of jaws of individual of *Tetrabelodon campester* represented in Plate IX., one-eighth natural size.

Plate XI.

Tetrabelodon angustidens proavus Cope, mandibular ramus and symphysis from above and in profile, one-sixth natural size. Fig. A, first true inferior molar of a young animal, one-third natural size. Fig. B, last superior premolar of young, perhaps of this species, two-fifths natural size.

[1] "Memoirs of the the Palæontographical Society," 1879, p. 69. Monograph of the British Fossil Elephants Pl. VI., VII.

ERRATUM.

Fig. 9, page 208, should read "1/7.7 natural size" in place of "natural size."

PLATE XII.

Tetrabelodon angustidens Cuv. Entire skeleton 1-26 natural size, restored by Gaudry. From the Miocene of France. From Gaudry "Enchainements du Régne Animal."

PLATE XIII.

Tetrabelodon euhypodon Cope, mandibular ramus from above and in profile, one-eighth natural size. From the Loup Fork bed of Kansas. Original.

PLATE XIV.

Elephas primigenius columbi Falc. Cranium. From Plistocene of Texas, 1-7.7 natural size. Original in Mus. E. D. Cope. The white spaces are light-colored bone, except at ends of premaxillaries, which are plaster.

PLATE XV.

Outlines of crania of Proboscidia, much reduced; from Falconer; front views.

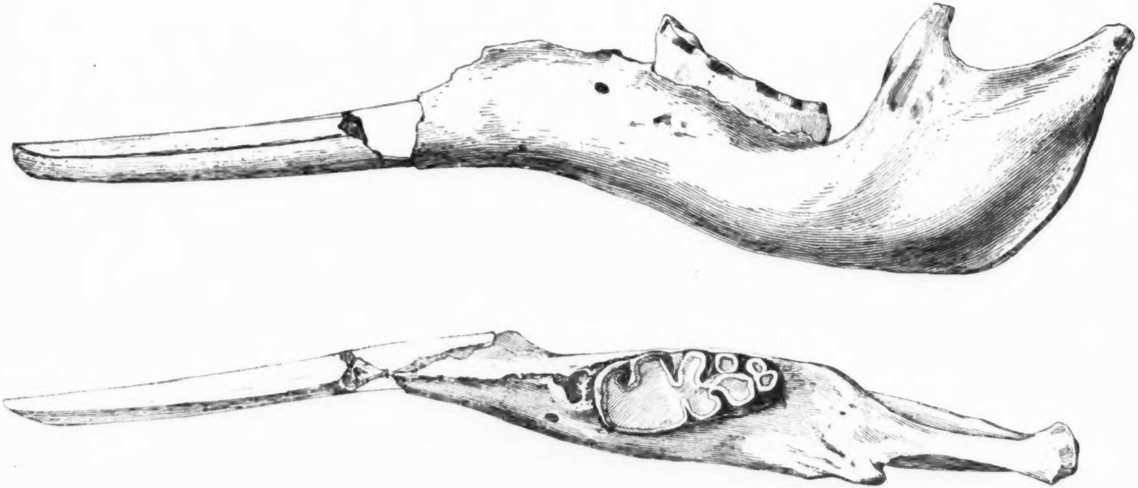
Fig. 1, *Dinotherium giganteum.* Fig. 2, *Mastodon americanus.* Fig. 3, *Dibelodon cordillerarum.* Fig. 4, *Mastodon perimensis.* Fig. 5, *Mastodon sivalensis.* Fig. 6, *Elephas bombifrons.* Fig. 7, *Elephas ganesa.* Fig. 8, *Elephas insignis,* including *a* and *b*, very young. Fig. 9, *Emmenodon planifrons.* Fig. 10, *Elephas africanus.* Fig. 11, *Elephas meridionalis.* Fig. 12, *Elephas hysudricus.* Fig. 13, *Elephas namadicus.* Fig. 14, *Elephas indicus,* including *a*, var. *mukna,* and *b*, young. Fig. 15, *Elephas primigenius,* after Fischer.

PLATE XVI.

Outlines of crania of Proboscidia, much reduced; from Falconer; profiles.

Fig. 1, *Dinotherium giganteum,* from Kaup. Fig. 2, *Mastodon americanus.* Fig. 3, *Tetrabelodon angustidens,* after De Blainville. Fig. 4, *Dibelodon cordillerarum.* Fig. 5, *Mastodon perimensis.* Fig. 6, *Mastodon sivalensis.* Fig. 7, *Mastodon arvernensis,* from Nesti. Fig. 8, *Tetrabelodon longirostris,*

PLATE XIII.



Tetrabelodon euhypodon Cope.

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after Kaup. Fig. 9, *Mastodon latidens.* Fig. 10, *Emmenodon elephantoides.* Fig. 11, *Elephas bombifrons.* Fig. 12, *Elephas ganesa.* Fig. 13, *Elephas insignis.* Fig. 14, *Emmenodon planifrons.* Fig. 15, *Elephas africanus.* Fig. 16, *Elephas meridionalis.* Fig. 17, *Elephas hysudricus.* Fig. 18, *Elephas namadicus.* Fig. 19, *Elephas indicus.* Fig. 20, *Elephas primigenius.*

ACROSS THE SANTA BARBARA CHANNEL.

BY J. WALTER FEWKES.

THE island of Santa Cruz, from the Mission Church of Santa Barbara, looks not unlike Capri, from the City of Naples. The same blue sky arches over it, the same Mediterranean haze envelops it, its outlines are softened by its distance, and its cliffs rise equally precipitantly from the sea. In my tarry at Santa Barbara, in the spring of 1887, I had repeatedly turned my eyes seaward, across the channel, longing for the opportunity, which at last came, to cross the intervening waters, and set foot on this island. My trip across the channel was productive of both pleasure and profit, and may not be without interest to my readers.

Although a comparatively narrow channel separates the Santa Barbara islands from the mainland, the means of communication are not always at hand. The enterprising fisherman, Larco, often crosses it in his Italian sailboat, the "Genova," but his accommodations for passengers are more or less limited. The vessel owned by the proprietors of the island was not at my disposal, and the only thing left was to charter a craft for my own use. Fortunately, it was possible to find such a vessel, and I was able to visit the nearest of the Santa Barbara islands, long ago discovered by Cabrillo, upon which, according to some authorities, he was buried.[1]

[1] Other historians say this intrepid discoverer found his grave at a neighboring island of San Miguel. Certain it is that he was the first European to sail up the Santa Barbara Channel, and that he lost his life on this voyage. His grave, wherever it may be, is not yet marked by monument or commemorative stone.

The "Angel Dolly," which is at anchor off the wharf at Santa Barbara, was found to be admirably suited for my trip, and after a few preparations, I embarked on her, and hoisting her sails, we turned her southward to the rocky cliffs of the island of the Holy Cross. The "Angel Dolly" is a small schooner of about twenty tons burden, with a cabin, which the passengers share with the captain, a forecastle for the crew, and a capacious hold. The crew consisted of a captain, one man before the mast, and a cook. The cabin I found well suited for my scientific work, and I transformed it into a laboratory, the mess table serving well for microscopic work when the vessel was on an even keel. My dredge, ropes, and nets were well stored in the hold, and at noon, in the middle of March, we hove anchor, set her sail, and went to sea. It had been my intention to visit the island of San Miguel, but the wind was so light that we shaped our course directly to Santa Cruz.

The weather, when we left Santa Barbara, was foggy, and after getting outside the zone of giant kelp,[1] we were becalmed. As a result we drifted back and forth all the afternoon, and finally found ourselves down the coast towards Carpenteria, the storehouse and wharf of which place we saw a few miles away, at nightfall. Although the distance across the channel is about twenty-eight miles, we made little progress that night, and drifted about in the fog until Sunday morning. After many calms, puffs of air, and baffling winds, we sighted, Sunday morning at ten o'clock, the lofty peak of Punta del Diablo, the most lofty headland on the island of Santa Cruz. We ran in toward the land, through the fog, to the neighborhood of the shore, and anchored in a small fiord at the base of Monte Diablo. This fiord, which we will call Star Cañon, is enclosed by lofty cliffs many hundred feet high. As we sailed into it, I saw, for the first time on the Pacific ocean, a large Salpa, which rivals the *Salpa maxima* of the Mediterranean, a floating Ascidian, the "solitary

[1] This zone forms a curious belt, skirting the shore at Santa Barbara. It is composed of the floating fronds of a giant alga (*Nereocystes*), and is situated about three hundred yards from the shore. This zone imparts a highly characteristic appearance to the coast of many parts of Southern California.

form" of which is as large as a man's hand, and the "chain form" is many yards in length.

Looking into the cañon[1] from our anchorage, we notice that the high cliffs of the brow, which appears an unbroken peak from Santa Barbara, have a cleft form with jagged edges, as if they had been broken asunder by volcanic forces. This effect is thought to be due to the recent elevation of the island, and to tell the same story as the raised terraces on the eastern and western ends of the island. In the chart, by the Coast Survey, a mountain called Ragged Mountain occupies the position of this break. The mode of formation of this cañon and fiord[2] is not wholly clear to me. That water has played an important part in its formation is doubtless true, but, at the same time, the sharp break indicates some other and more violent geologic agency. The perpendicular walls of the cañon are certainly from 600 to 900 feet high. The cañon makes up through the mountains, and in the present season a good stream of fresh water flows out of it past the shingly beach to the cove. On the mountain side we noticed little vegetation, but here and there a clump of prickly pears, and small bushes with yellow poppy flowers. The rock is a coarse conglomerate, the embedded boulders of black asphaltic color, and the matrix red. The matrix is in many places very much eroded, and the hard, embedded, angular rocks stand out in relief, sometimes clinging to the cliff by a single edge. The embedded rocks are angular, and little waterworn, except where they are exposed to wave action.

[1] This fiord is almost directly opposite Santa Barbara, under the high peak, which appears from this city to be the apex, or highest point of the island. Its name is not given on the excellent chart of the island, which I made use of on my trip.

[2] From my work with the dredge I am led to believe that these chasms in the islands which are called cañons extend for some distance under the water. I have found records that the officers of the Coast Survey have made similar observations. If such a submarine continuation of these cañons occur, it is difficult to explain them as wholly the result of erosion, or if of aerial erosion, the islands may have sunk subsequent to this action. The evidence on the west end of the island points to elevation, or in this way the elevated terraces were interpreted.

Some of the neighboring islands like Anacapa, show similar elevation, with enormous denudation. The form of this island from the sea is highly suggestive, but I was unable to land upon it.

The fiord in which the "Angel Dolly" rides at anchor is well protected from the prevalent gales, and the water, although deep, is easily sounded by our anchor. We anchored near the shore, not far from the beach, at the end of the cañon. After all had been made snug aboard, we rowed to the shore, and took a stroll up the cañon, following the bed of the brook. The cañon is well wooded with many kinds of trees, and with ferns and mosses, with here and there, wild flowers. As we landed on the shore we started up two small, wild foxes, *Urocyon littoralis*, so abundant on the island, and came within easy gunshot of them.

On each side of the cañon the cliffs rise precipitantly, almost perpendicularly, so that it is impossible to climb them, and it is with great difficulty that we made our way along their base. Many large boulders lie strewn along the bed of the stream, and there are many deep basins of pure, fresh water, fed by the sparkling mountain stream from the cañon. In one or two places the bed of the stream is dry, the water having made a channel for itself through passages under the rock or soil. At certain places these dry sections of the bed of the stream are coated with a white deposit. There were many cottonwood trees as far up the cañon as we were able to penetrate. Near the beach we noticed the remains of an old camp-fire, and the skins of two sheep, which told the story of a former camping party, probably of fishermen, visitors to this lonely and picturesque place. There are also many abalone shells (*Haliotis*), the animals of which had also, no doubt formed part of the meal of these visitors.

The level deposit of soil at the mouth of the cañon must have been a favorite camping place for the Indians who once lived in great numbers on this and neighboring islands, for on the side hill there is a high shell heap where they had thrown the debris of their camp. This shell heap was formed in great part of the shells of a large Balanus, Haliotis, and Mussels. On the sides of the rocks above it many Indian inscriptions were cut in the hard rocks of the conglomerate. These inscriptions were made with some care and consist of parallel grooves in the rock across which, at right angles, were other grooves all of undoubted Indian origin. We returned to the

PLATE XIV.

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"Angel Dolly" and transported our cooking utensils on shore preparatory to a camp there under the brow of the cliffs of the cañon.

In the afternoon I took a sailor and one of the seal boats of the schooner and rowed down the shore to the westward under Punta del Diablo to the "Seal Rookery." This boat ride was the most wonderful trip which I have ever taken on the coast of California. The cliffs to the west of Star Cañon rise perpendicularly to the height of many hundred feet, so that it is impossible to climb them except in the small fiords or cañons which extend into the mountains. Immediately after rounding the high headland to the west of Star Cañon we come to the first cañon, which is well wooded and surrounded by mountains which are grandly picturesque. We did not land in this fiord but continued to the second, which was even more rugged and abrupt than the first. This cañon presented to us a landing place, and we rowed through the heavy surf, landing on a small beach. The cañon is well wooded but closed a short distance from the beach by a high boulder, which has fallen into it, so that the cañon is almost blocked up. The boulders, which stop up several of the cañons, are thought to have been eroded from the cliff in the position they at present occupy, and not to have been transported from higher up the cañon by water or ice.[1]

We made our way back of the boulder through a crevice between it and the cliff and continued up the cañon a few hundred yards, but the way gets more difficult, the loose

[1]Something analogous to this is to be seen in the boulders of red sandstone which are strewn along on the mesa at the foot of the Santa Inez mountains back of Santa Barbara. These rocks are sometimes of great size and, according to Whitney, were washed down from the mountains which everywhere show signs of great erosion. They become very thickly massed together in some places and often reach enormous proportions. I was unable to find glacial striæ on the sides of the Santa Yeury range although I repeatedly looked for them.

One of the most famous of these large erratic rocks is that near Montecito which bears the Indian inscription done in red paint. Beyond the Mission Church they are very numerous in some places blocking up the cañons as in the island of Santa Cruz. In some places they are so numerous that they almost form boulder rivers. Just back of the Spanish part of Santa Barbara between the city and the mesa there are many eroded valleys and as we pass over the mesa to the foot of the Santa Yeury range the erratic rocks increase in size and number.

rocks more numerous and the walls of the cañon more and more precipitant. The same conglomerate is present here as at Star Cañon, near which our schooner is anchored.

I made a sketch of the place and took again to boat passing under the brow of Punta del Diablo, one of the grandest points of the island.

Under the base of Diablo opens "Devil's Cañon" or "Devil's Cove," a most picturesque, wild and rugged combination of land and sea. In this part of Santa Cruz there are no beaches and no zone of kelp, but the water sinks to a great depth hard by the shore, and dredging was impossible with the implements at my disposal. At the base of Punta del Diablo there are two conical elevations rising as islands out of the sea. These elevations when approached from the east appear perfectly symmetrical, the more distant from the point being capped by an eagle's high nest. The hills are green to their summits.

Near these conical islands we rowed into a grotto of wonderful beauty. It extends deep under the mountain and as our boat made its way in, we saw many seals and sea-lions on the ledges of the rock. As we rowed in, these huge animals dove into the sea with hoarse barking and swam into the depths of the cave. We fired at them with our rifles and the reverberation was something deafening. In the cave, which extended many feet beyond, a tremendous sea was rushing at every incoming wave. The whole grotto reminded me of the famous grotto of Capri in the Bay of Naples.

Beyond Punta del Diablo the cliffs take the form of a gigantic saw, the top of the precipices being worn out into valleys which are symmetrical one after another. Beneath these saw-like valleys the rock shows much erosion especially near the level of the sea At one place a perfectly formed human figure which appears to be in the act of stepping into the sea, can be made out. A tremendous surf breaks on the base of the cliffs and here and there where there are partially submarine grottos or caves the escaping air throws the water to great heights with a loud noise.[1] Behind us the monster

[1]These spouts of water thrown into the air by the resistance of the air compressed in a half submarine grotto by an incoming wave are among the most interesting

cliff of Punta del Diablo extends almost perpendicularly out of the water. The view of the coast looking both east and west is perfectly grand. Away to the west we sight the conical rocks and islands which form the eastern side of the "Seal Rookery."

As we row along we see here and there on the sides of the cañons a few sheep and one or two wild hogs. The east side of the Seal Rookery is bounded by islands with natural arches and lofty cliffs. Off these islands a short distance there is a small island with a flat top, and near it are two beautiful natural arches. The flat rock is white with guano, and the natural arches are high enough to allow a boat to pass under them. There is no landing place of any size at the Rookery, but vast numbers of seal are seen basking in the sun. Here we see much kelp, and for the most part the coast everywhere is bold and rugged. At the Seal Rookery we turn back towards Star Cañon and after a hard pull we came at last to the smooth water in which the schooner is at anchor.

One of the most beautiful of all the cañons which we passed was Lady's Cañon, a most picturesque place with smooth water and cliffs rising on all sides. The scenery here is very grand. Floating kelp was found at several places and one or two gigantic floats of the "Sea-Onion" were found, but as a general thing the coast is bare and no zone of kelp like that of Santa Barbara was seen.

phenomena of the coast. Their height is often very considerable and the noise with which the water is forced out is often very great. The surf upon the base of the cliffs is often very heavy after the sudden winds which often arise without a moment's warning.

The sudden and local character of the gusts of wind is in some cases due to the cañon configuration of the coast. A most marked instance illustrative of this explanation was experienced in my approach a few weeks later to the harbor of Port Harford the port of San Luis Obispo. We had steamed along the whole afternoon over a tranquil sea without a ripple when suddenly on our approach to this port there came down a violent gust of wind out of the cañon such that the steamer seemed to pass immediately into a raging tempest which as suddenly ceased when we drew up at the wharf.

(To be continued.)

THE POLAR DIFFERENTIATION OF VOLVOX, AND THE SPECIALIZATION OF POSSIBLE ANTERIOR SENSE-ORGANS.

BY JOHN A. RYDER.

IN a recent communication upon this subject which the writer made to the Academy of Natural Sciences of Philadelphia, the fact was pointed out that in *Volvox minor* there are very distinctly differentiated anterior and posterior poles or hemispheres. The anterior or empty pole is so named here because it is the one which is always directed forwards when the animal is in motion. The posterior pole is so named because it is always in a posterior position when the organism is moving freely and normally, and it is further distinguished from the anterior in that it is in this hemisphere, in *V. minor* at least, in which the germs are produced which give rise to young Volvoces. Roughly speaking the nearly spherical cænobium or colony of Volvox may be divided into an anterior and a posterior hemisphere. Through the centres of these hemispheres there passes an imaginary axis around which the colony rotates in either a sinistral or dextral direction, but progressive locomotion is always in the direction of the anterior empty pole of the cænobium. This differentiation of the poles of the colonies of Volvox appears to have been known to Ehrenberg, who figures them but makes no farther mention of the fact. Hicks is reported in the *Midland Naturalist*, 1880, to have observed that the young leave the parent cænobium by breaking through the wall of the hinder or spore-bearing hemisphere, a fact which I can confirm.

While these facts have been partially recorded by previous observers, there is another group of facts which I have noticed which are far more important and remarkable and serve to establish beyond question the polar differentiation of Volvox, and also raise the suspicion that this animal or plant, whichever it is, is endowed with a very primitive sensory apparatus which is developed to an importance anteriorly, eight or ten times as great as at the posterior pole. It is well known that

each one of the biflagellate cells of Volvox contain superficially embedded a reddish lenticular refringent body known since Ehrenberg's time as "eyes" or "eye spots." One of these "eye spots" lies not very far from the base of one of the flagella in each cell, and produces a slight rounded projection of the thin layer of clear protoplasm immediately overlying and surrounding it. In optic section these reddish bodies are seen to be lenticular or nearly so, the outer face being less convex than the inner. This is best seen in the "eye-spots" of the anterior pole. These "eye-spots" strange to say, bear a constant and definite relation to both the imaginary axis around which the colony revolves and the flagella of its cells. They are placed not quite on the extreme outer periphery of the cells as reckoned from the centre of the globular colony, but nearly so. The anterior ones at the anterior pole consequently look forward, while the others of the rest of the cells look in all other directions, the hindmost ones looking directly backward.

Now comes the most singular and interesting fact which I have observed, viz: *that the "eye-spots" of the cells of the anterior pole are eight to ten times as large as those of the hinder pole.* The passage from the large "eye-spots" of the anterior pole to the smaller ones of the posterior pole is very gradual, as can be readily observed with a moderately high power. These "eye-spots" diminish so much in size on passing to the cells of the posterior pole as to be finally visible only as a minute refringent reddish globule pushing out the protoplasm of the cell slightly in the same way as the larger anterior "eye-spots" push out the superficial plasma of the cells of the anterior pole.

It is therefore plain that if these organs are visual or sensitive to light or any other natural agent, they are best developed in just the position in which they are of the most service to the organism, viz., at its anterior pole. These facts raise the query whether Ehrenberg was not after all justified in regarding the reddish spot in each cell of the colony as *eyes.* While these eyes are obvious to any observer it is remarkable that no one has hitherto called attention to their very unequal development at

the anterior and posterior poles of Volvox. It is equally remarkable that none of the extant figures of Volvox correctly represent the definite relation of position of the "eye-spots" to the axis of rotation of the whole cænobium or colony and the flagella of the cells.

The facts which are here noted in regard to Volvox serve rather to strengthen the claims of zoologists to this singular organism, which is actually found to combine features of the vegetable and animal world in its physiological activities. While its respiration, chlorophyl, and modes of reproduction seem to affiliate it with the plant kingdom, the obvious differentiation of a system of anterior organs, which refuse any other identification than that of sensiferous structures give it claims upon the animal kingdom. If we look upon Volvox as a form which has permanently not passed beyond the ideal blastula stage and which lies near the point of divergence of Metaphyta from the Metazoa we shall probably assign it to nearly its true position. It has many interesting features, one of which is its blastula-like form; its cells embedded in cellulose and united by protoplasmic bonds into a sort of syncytium; its differentiation of a directive anterior empty pole apparently provided with a more specialized sensory apparatus, as pointed out above, and of a posterior reproductive pole or hemisphere, in the cells of which the supposed sensory apparatus is so reduced in importance as to have been nearly suppressed. Carrying our reflections farther, we may be permitted to suppose that conditions of organization may and do exist, as evidenced in Volvox as here described, in which structures and functions may be manifested, which we must regard as sensiferous, yet in so low and generalized a form in a blastula-like type, that we find the organs developed in every cell, the only evidence of differentiation or specialization obtainable being that which occurs at that pole of the blastula which is habitually brought into the most important or dangerous relation to the environment. The end result being that a type comparable to the hollow blastula has the sensiferous apparatuses of the cells at its constant anterior pole better developed than in

those around its equator and still better than in those at its constant posterior pole. The diffusion or extension of the primordial visual apparatus of the protozoan grade such as is seen in Euglena, is a result merely, in Volvox, of the permanent attainment of the colonial grade of development which has ended in a sort of blastula-like form, each cell of which is provided with a sense organ. In other words we have in Volvox a blastula-like type with a sensory apparatus apparently developed at its anterior pole, while at its posterior pole this sensory apparatus is so little developed as to be nearly absent, possibly owing to disuse. The degree of development of this supposed sensiferous apparatus at opposite poles in Volvox stands in an obvious relation to the respective importance of such a contrivance at those poles in relation to the welfare of the organism. It is probable that, if what I have here described is really a visual or other sensory apparatus, it is the most primitive and unspecialized compound sensiferous organ yet detected in the living world. At any rate it is probably to be regarded as a compound organ in the same sense that the retina and ommatidia of other and higher forms are to be regarded as compound organs in that they are cellular aggregates. The further study of these remarkable structures and relations in Volvox is desirable, and as the organism is accessible to many students it is to be hoped that such study may not be long delayed, and that not only a more careful study of the minute structure of the "eye-spots" may be carried out, but also that figures will be produced which will give adequate prominence to the most important of the facts which I have here attempted to put upon record.

THE DEVELOPMENT OF THE THEORIES OF CRYSTAL STRUCTURE.[1]

IN 1822, the Abbé Haüy[2] declared that since all crystals of the same substance, whatever their external form, may be

[1] Abstracted by. W. S. Bayley from an article by H. A. Miers in *Nature* of January 17, 1889.

[2] "Traité de Cristallographie." (Paris, 1822.)

reduced by cleavage to the same solid figure, this cleavage solid has the form of the ultimate particles into which any crystal may, in imagination, be separated by repeated subdivision, and that this is, therefore, the form of the structural unit, although not necessarily that of the chemical molecule. Hence a crystal is to be regarded as constructed of polyhedral particles, having the form of the cleavage fragment, placed beside one another in parallel positions. A crystal of salt, for example, which naturally cleaves parallel to the faces of the cube, is constructed of cubic particles.

Upon the relative dimensions of the structural unit depends the form assumed by the crystals of a given substance.

This theory not only accounts for the existence of cleavage, but further defines the faces which may occur upon crystals of a substance having a given cleavage figure; for, if once it is assumed that a crystal-face is formed by a series of the particles whose centres lie in a plane, it follows that all such planes obey the well-known law which governs the relative positions of crystal-faces.

A natural advance was made from the theory of Haüy, without detracting from its generality, by supposing each polyhedral particle in Haüy's system to be condensed into a point at its centre of mass, so that the positions of the molecules, and therefore of the crystalline planes, remain the same as before; but the space occupied by a crystal is now filled, not by a continuous structure resembling brickwork, but by a system of separate points.

In such a system of points, if the straight line joining any pair be produced indefinately in both directions, it will carry particles of the system at equal intervals along its entire length; in other words, all the structural molecules of a crystal must lie at equal distances from each other along straight lines. The interval between particles along one straight line will, in general, be different from those along another, but the molecular intervals along parallel straight lines will always be the same.

Bravais,[1] following in the steps of Delafosse and Franken-

[1] "Etudes cristallographiques." (Paris, 1866.)

PLAT

Fig. 1

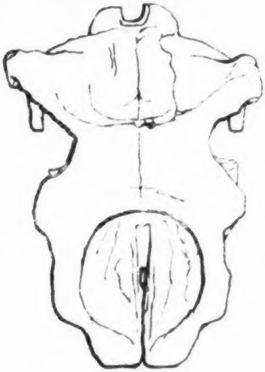


Fig. 2.

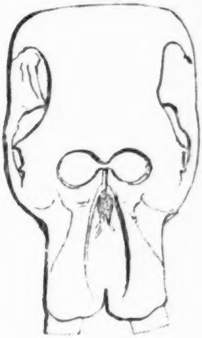


Fig. 3.

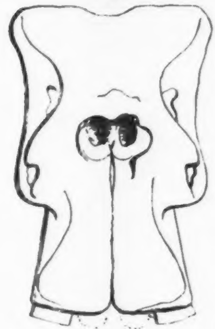


Fig. 4.

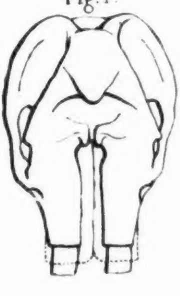


Fig. 5.

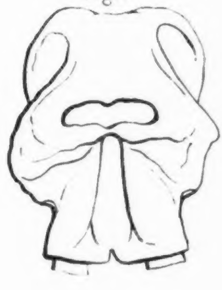


Fig. 6.

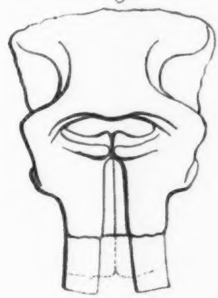


Fig. 8.

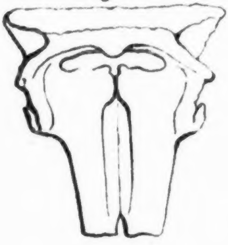


Fig. 7.

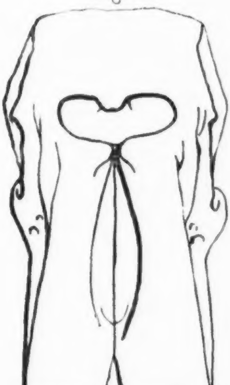


Fig. 8a

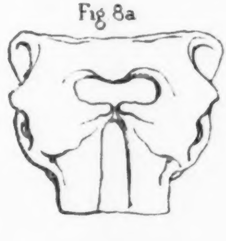
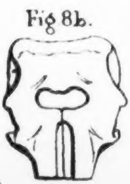


Fig. 8b.



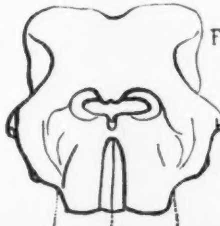


Fig. 9

PLATE XV.

Fig. 3.

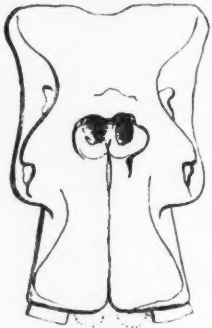
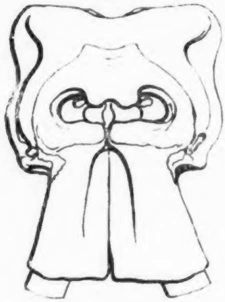


Fig. 10.



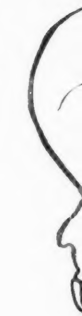


Fig 6.

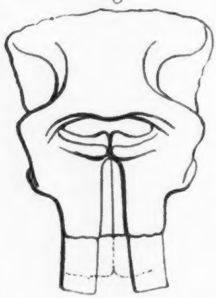


Fig. 11.

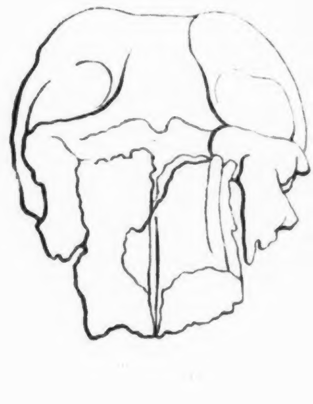


Fig 8a

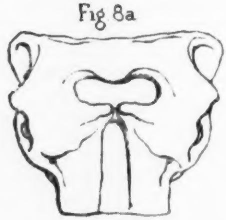


Fig. 14.

Fig. 9

Crania of Proboscidia.

Fig.12.

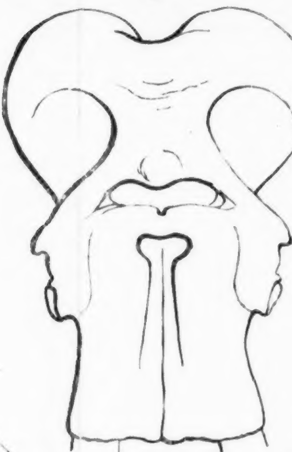


Fig.12a.

Fig.13.

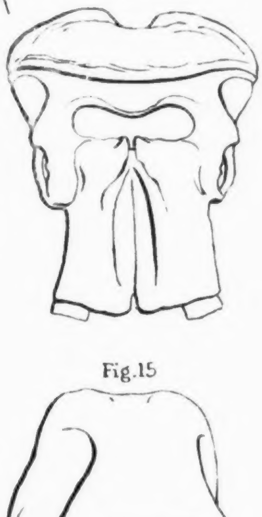


Fig 14b.

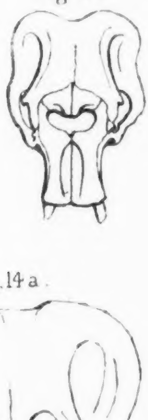


Fig.14a.

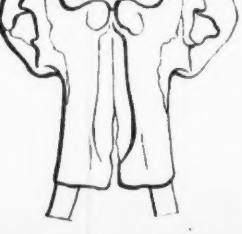


Fig.15

heim, investigated the possible ways in which a system of points may be arranged in space so as to lie at equal distances along straight lines—in other words, so as to constitute what may be called a *solid network* (*assemblage, Raumgitter*).

The geometrical nature of a network may be best realized as follows: Take any pair (O C_1) of points in space, draw a straight line through them, and place points at equal distances along its entire length (C_2, C_3, . . .); such a line may be called a *thread* of points (*rangée*). Parallel to this line, and at any distance from it, place a second thread of points (A_1 a_1), identical with the first in all respects; in the plane containing these two threads place a series of similar equidistant parallel threads ($A_2 a_2$, &c.) in such positions that the points in successive threads lie at equal intervals upon straight lines whose direction (O A_1) is determined by the points upon the first two threads. Such a system of points lying in one plane may be called a *web* (*réseau*). Now, parallel to this plane, and at any distance from it, place a second web (B_1 b_1), identical with the first. Finally, parallel with these, place a series of similar equidistant webs in such positions that the points in successive planes lie at equal intervals upon straight lines whose direction (O B_1) is determined by the points in the first two webs.

In this way a *network* of points is constructed, in which the line joining any two points is a *thread*, and the plane through any three points is a *web*.

The space inclosed by six adjacent planes of the system, having no other points of the network between them is a parallelopiped (O A_1 B_1 C_1), from which the whole system may be constructed by repetition, and which may be taken to represent the structural element (*molécule soustractive*) of Haüy.

The complete investigation of all possible solid networks led Bravais to the conclusion that these, if classified by the character of their symmetry, fall into groups, which correspond exactly to the systems into which crystals are grouped in accordance with their symmetry.

It follows that two (not, however, independent) features of crystals are fully accounted for by a parallelopipedal arrange-

ment of points in space—namely, the symmetry of the crystallographic systems and the law which governs the inclinations of the faces (law of rational indices).

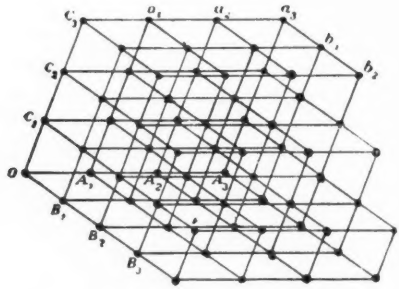


Fig 1

There are, however, subdivisions of the various systems consisting of the merohedral or partially symmetrical crystals belonging to them, which are not explained by the geometry of a network; these consequently were referred by Bravais, not merely to the arrangement of the molecules in space, but also to the internal symmetry of the molecule itself.

Hence the theory of Bravais, while able to a certain extent to explain the form of crystals, requires an auxiliary hypothesis if it is to explain those modifications which are partially symmetrical or merohedral.

Sohncke,[1] treating the problem in a different manner, and reasoning from the fact that the properties of a crystal are the same at any one point within its mass as at any other, but different along different directions, inquired in how many ways a system of points may be arranged in space so that the configuration of the system round any one point is precisely similar to that round any other. Such a configuration may be called a *Sohncke system* of points in space (*regelmässiges Punktsystem*).

From his analysis of this problem, it appears that there are

[1] "Entwickelung einer Theorie der Krystallstruktur." (Leipzig, 1879).

sixty-five possible Sohncke systems of points, and that these may be grouped according to their symmetry into six classes, corresponding to the six crystallographic systems; and further that there are within each class minor subdivisions, characterized by a partial symmetry corresponding to the hemihedral and tetartohedral forms of crystallographers.

The theory of Sohncke contains within itself the essential features of a Bravais network of structural molecules, and also the auxiliary hypothesis regarding the arrangement of parts within the molecules which is required to account for merohedrism. On close examination the arrangement of Sohncke proves to be a simple extension of that of Bravais.

Each of Sohncke's arrangements may be regarded as derived from one of the parallelopipedal networks of Bravais if for every point of the latter be substituted a group of symmetrically arranged satellites. It is not necessary that any particle in a group of these satellites should actually coincide with the point of the Bravais network from which the group is derived; and the points of the Sohncke system do not themselves form a network; it is only when all the points in each group of satellites are condensed into one centre that a Sohncke system coincides with a Bravais network.

To any particle of one of the satellite groups corresponds in every other group a particle similarly situated with regard to the point from which the group has been derived. Every such point may be said to be homologous with the first.

Each complete set of homologous points is itself a Bravais network in space, and consequently a Sohncke system may be regarded as a certain number of congruent networks interpenetrating one another: the number of such networks, in general, being equal to the number of points which constitute each group of satellites.

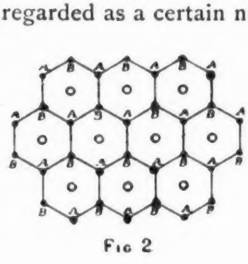


FIG 2

The relation of a Sohncke system to the network from which it is derived may be illustrated by a bees'-cell distribution of points in one

plane, *i. e.*, by points which occupy the angles of a series of regular hexagons. Thus, in the adjoining figure the dots form a Sohncke system in one plane, since the configuration of the system round any one point is similar to that round any other; but they do not form a Bravais web, since the points do not lie at equal distances along straight lines.

If, however, points, represented in the figure by the circles O, be placed at the centres of the hexagons, they will by themselves constitute a web, and the hexagonal system may be derived from this web by replacing each of its points by a group of two satellites, A and B. Or, from the second point of view, the arrangement may be regarded as a triangular web, containing the points A, completely interpenetrated by a similar web, containing the points B.

It is a remarkable feature of the Sohncke systems that some among them are characterized by a spiral disposition of the particles along the threads of a right- or left-handed screw: now this spiral character, which does not belong to any of the Bravais networks, supplies a geometrical basis for the right- or left-handed nature of some merohedral crystals which possess the property of right- or left-handed rotary polarization.

The theory of Sohncke, as sketched above, appeared to be expressed in the most general form possible, and to include all conceivable varieties of crystalline symmetry.

It has, however, recently been pointed out by Wulff[1] that the partial symmetry of certain crystals belonging to the rhombohedral system—that, namely, of the minerals phenacite and dioptase—is not represented among the sixty-five arrangements of Sohncke.

Other systems of points in space have also been studied by Haag[2] and Wulff, which do not exactly possess the properties of a Sohncke system, and yet might reasonably be adopted as the basis of crystalline structure, since they lead to known crystalline forms.[3] These, however, and all other systems of

[1] *Zeitschr. f. Kryst.* xiii. (1887) p. 503.

[2] "Die regulären Krystallkörper." (Rottweil, 1887.)

[3] Cf. W. Barlow, *Nature*, xxix. (1884) pp. 186, 205.

points which have been proposed to account for the geometrical and physical properties of crystals, may be included in the theory of Sohncke after this has received the simple extension which is now added by its author.

In Bravais's network all the particles or structural elements were supposed to be identical, and in Sohncke's theory also there is nothing in their geometrical character to distinguish one particle from another.

In Fig. 2, the hexagonal series of dots may, as was said above, be regarded as composed of a pair of triangular webs, A and B; now these, although identical in other respects, are not parallel, for the distribution of the system round any point of A is not the same as that round any point of B until it has been rotated through an angle of 60°.

It is possible, however, to conceive similar interpenetrating networks which differ not only in their orientation but even in the character of their particles. The centre of each hexagon, for example, may be occupied by a particle of different nature from A and B to form a new web, O. The three webs are precisely similar in one respect, since their meshes are equal equilateral triangles; moreover, if the *position* of the points alone be taken into account, the whole system would form a Bravais web, *i. e.*, if the particles of O were identical with those of A and B. If, however, as is here supposed, the set O consists of particles different in character from A and B, the distribution round any point of O is totally distinct from that round any point of A or B. The points O are geometrically different from the points A B. The web A is interchangeable with B, but O is interchangeable with neither The interpenetrating networks are no longer to be regarded as consisting necessarily of identical particles, if an explanation is to be given of all the geometrical forms existing in nature.

The above figure represents a Sohncke system, A B, of particles of one sort interpenetrated by a Bravais web, O, of another sort; but there is no reason why two or more different Sohncke systems, no one of which is identical with a Bravais network, may not interpenetrate to form a crystal structure.

In its most general form, then, the theory may now be expressed—

A crystal consists of a finite number of interpenetrating Sohncke systems which are derived from the same Bravais network. The constituent Sohncke systems are in general not interchangeable, and the structural elements of one are not necessarily the same as those of another.

Or, since each Sohncke system consists itself of a set of interpenetrating networks, the theory may be thus expressed—

A crystal consists of a finite number of parallel interpenetrating congruent networks: the particles of any one network are parallel and interchangeable; these networks group themselves into a number of Sohncke systems in each of which the particles are interchangeable but not necessarily parallel.

The number of kinds of particles which constitute the crystal may therefore be equal to the number of Sohncke systems involved in its construction.

The structural units are no longer, as they were in the theory of Bravais, necessarily identical, but may represent atomatic groups of different nature.

The system in Fig. 2 consists of two sets of particles, A B and O; and, if a large enough number of these be taken, any portion of the system (*i. e.* any crystal constructed in this manner) consists of the particles united in the proportion of two of the first group to one of the second. Such an arrangement, then, may represent the structure of a compound, $O\ A_2$.

"When, for example, a salt in crystallizing takes up so-called water of crystallization which is only retained so long as the crystalline state endures, the chemical molecule salt + water cannot be said to exist except in the imagination, for the presence of such a molecule cannot be proved. To obtain an easily intelligible example, without, however, pronouncing any opinion as to whether it may be realized, imagine the centred hexagons in the figure to be constructed in such a way that each corner consists of the triple molecule $3\ H_2O$, and each centre consists of the molecule R. The chemical formula would then be $R + 6H_2O$, and yet a molecule of this constitution

would not really exist; on the contrary, the structural elements in the crystallized salt would be of two sorts—namely, R and $3H_2O$."[1]

Hence it is geometrically possible that the structural elements of a crystal may be different atomic groups which are held in a position of stable equilibrium by virtue of being interpenetrating networks.

A GENERAL PRELIMINARY DESCRIPTION OF THE DEVONIAN ROCKS OF IOWA; WHICH CONSTITUTE A TYPICAL SECTION OF THE DEVONIAN FORMATION OF THE INTERIOR CONTINENTAL AREA OF NORTH AMERICA.

BY CLEMENT L. WEBSTER.

The area of the Devonian rocks in North America presents at least four distinct types of stratigraphy in their sections, in different parts of the continent.

The four types blend, more or less, at their borders, but in their central area are quite distinct.

The four areas may be called,—

(1) "*The Eastern Border Area*," including the outcrops of Gaspé, New Brunswick, Maine, and other places in Northern New England.

(2) "*The Eastern Continental Area*," including the New York and Appalachian tracts as far South as West Virginia, and extending Northwestward into Canada West and Michigan.

(3) "*The Interior Continental Area*," typically seen in Iowa, and extending into Missouri, Illinois, Indiana, and probably Northward toward the valley of the Mackenzie River, and—

(4) "*The Western Continental Area*," best known through Hague and Walcott's studies of the Eureka, Nevada, sections.[2]

Each of these four types presents sections of the Devonian, which

1 Sohncke, *Zeitsch. f. Kryst.* xiv. p. 443.

2 This classification of (in part) Professor H. S. Williams (American Geologist, Special Number, October, 1888, p. 228) we here adopt, provisionally.

in most of the details of stratigraphical, lithological and palaeontological composition, differs greatly from the others; although all at the same time, by various links of evidence, demonstrate that they represent the same geological age, and usually show, more or less distinctly, a similar order of sequence.

In this report it is our aim to deal, more particularly, with the typical section (Iowa) of the Interior Continental Area.

The area of surface occupied by the rocks of Devonian age in Iowa comprises a wide strip of country, the general trend of which is Northwestward and Southeastward.

It is about two hundred miles in length and fifty miles in width; the general details of its outlines may be seen upon the geological map of the State; which, however, demands some important modifications.

The rocks of this age, in Iowa, have been referred by geologists to different epochs; for instance, the shales and sandstone, which occupy the upper portion of the Devonian stratum near the mouth of Pine Creek, and at other points on the Mississippi, to the Chemung group; and the limestone and shales, occupying a "lower"? horizon, at Davenport, Iowa City, Independence, &c., and the shales at Rockford and Hackberry, to the Hamilton Group (Hall's Geology of Iowa, VOL. I. PART 1 and 2, 1850).

The rocks also at Cedar Falls, have been referred by Professor A. H. Worthen, to the Chemung group (*Loc. cit.*)

Some years later, in 1873, a reëxamination of some of the rocks of this age was made by Hall and Whitfield, and the limestone at Waterloo, and the shales at Rockford, were declared to be the equivalents of the New York Corniferous and Chemung Groups, respectively (23d Report on State Cabinet of New York, pp.,223-226) Again, Prof. H. S. Williams, in 1883 (American Journal of Science, February, 1883), referred the shales at the top of the Devonian, at Rockford and Hackberry, to the base of the Chemung of the New York Geologists, and, more recently, to the upper part of the Hamilton of the New York Section (American Geologist, Special Number, 1888, pp, 240, 242, &c.).

On the other hand, Dr. C. A. White (Geology of Iowa, 1870, VOL. I., p. 178) is of opinion that *all* the Devonian strata of Iowa, belong to a single epoch, the Hamilton.

By various other writers, the rocks of this age have been referred to each of the several divisions of the New York section.

The thickness of the Devonian rocks of Iowa, have been variously estimated by different writers on the subject, at from 150 feet to 200 feet.[1] This formation is quite conformable both with the Niagara rocks below, and the Carboniferous rocks above, throughout nearly, or quite their entire extent in the State. These rocks, as they occur in this State, are separable into *three* general, more or less well marked lithological and palaeontological divisions, and whose order of sequence can be made out.

The lowest division of this section, which, in its general lithological character, as observed in its Eastern extension at different points along the Mississippi, at, and adjacent to Davenport, is a rather hard, gray, brown, and buff limestone; at times somewhat arenaceous and argillaceous, with slight intercalated beds of shale, and gray and brown brecciated limestone, sometimes attaining a thickness of eight feet. A portion at least, of the rocks of this division, are here separated from the underlying Niagara limestone by a fault, the space being filled by coal measure deposits.[2]

This formation carries, at different horizons, a rich and varied fauna; while at other horizons, the strata are devoid of organic remains.

These rocks contain a fauna which represents both the Corniferous, Hamilton, and Chemung faunas, as well as a few forms characteristic of the Trenton and Niagara rocks below. Of the very large numbers of species of fossils (more than two hundred) collected from these rocks, over three-fourths are found to be characteristic of the Corniferous epoch. Of those forms representing the fauna of other epochs, their ratio of occurrence is, as in the following order: Hamilton, Niagara, Chemung and Trenton.

Or in other words, the larger number are peculiar to the Hamilton group, the second largest number are peculiar to the Niagara group, the third Chemung, and the fourth Trenton.

The following enumeration is that of some of the species characteristic of this division:

Arcophyllum oneidense	Cladopora fisheri
Callonema bellatulum	Cystiphyllum impositum
Callonema lateradum	Cystiphyllum vadum

[1] Hall's Geology of Iowa, Vol. I., Part I, 1858; C. A. White, Geology of Iowa, 1870; J. D. Dana, Manual of Geology, p 267; H. S. Williams, American Geologist, Special Number, October, 1888, p 233.

[2] A. S. Tiffany, Geology of Scott County, Iowa, and Rock Island County, Illinois, &c., p. 13.

Diphyphyllum simcoense	Leperdita cayuga
Orhoceras faculum	Producteila subaculeata
Strophodonta nacrea	Syringopora nobilis
Syringopora perelegans	Syringostroma columnare
Syringostroma densum	Zaphrentis exigua
Zaphrentis nitida	Zaphrentis subconstricta
Acrophyllum oneidaense	Alveolites squamosus
Alveolites subramosus	Atrypa aspera
Atrypa hystrix	Atrypa reticularis
Aulacophyllum convergens	Aulacoplyllum reflexum
Aulacophyllum princeps	Bellerophon pelops
Blothrophyllum promissum	Centronella glansfagea
Centronella hecate	Chonetes lineata
Chonophyllum vandum	Cladopora labiosa
Cladopora pinguis	Cladopora pulchra
Cladopora robusta	Clisiophyllum convergens
Clisiophyllum ohioense	Crania bordeni
Callonema imitator	Cyathophyllum arctifossum
Cyathophyllum clintonensis	Cyathophyllum coalitum
Cyathophyllum cornicula	Cyathophyllum conigerum
Cyathophyllum impositum	Cyathophyllum houghtonii
Cystiphyllum ohioense	Cyathophyllum davidsonii
Favosites canadensis	Favosites basalticus
Favosites limitaris	Favosites emmonsii
Orthis iowensis	Naticopsis humilis
Platyceras carinatum	Paracyclas lirata
Pleurotomaria hebe	Pleurotomaria aplata
Phillipsastrea gigas	Pleurotomaria rotalia
Spirifera fimbriata	Proetus canaliculatus
Spirifera gregaria	Spirifera mucronata
Spirifera varicosa	Spirifera euruteines
Strophodonta hemispherica	Strophodonta concava
Terebratula elia	Strophodonta patersonii
Zaphrentis compressa	Zaphrentis cruciforme
Zaphrentis exigua	Zaphrentis conigera
Zaphrentis prolifica	Zaphrentis gigantea
Zaphrentis wortheni [1]	Zaphrentis ungula

[1] For a portion of this list of species we are indebted to Mr. A. S. Tiffany, of Davenport, Iowa,

No well-marked lithological or biological sub-division of these rocks has been observed.[1]

In the eastern extension of the Corniferous rocks, in Iowa, they are seen to be succeeded upward by gray, brown and buff, calcareous and argillaceous shales, limestone, and coarse and fine-grained sandstones of the Hamilton group.

While at some localities the two divisions are sharply defined, both lithologically and biologically, still at other points these characters of the two formations so gradually blend as to make it a matter of great difficulty, if not an impossibility, to designate just where the line of separation between the two groups should be drawn.

As might be naturally expected, throughout the area occupied by these divisions, the mingling of their faunas is much more strongly marked at their junction with each other.

In their interior area, the line of division between the two groups is nowhere distinctly shown, either by lithological or biological evidence. According to the record of the boring of the artesian well at Davenport, kindly furnished me by Mr. A. S. Tiffany, and which may be considered as approximate, the thickness of the Corniferous rocks, in that vicinity, is shown to be one hundred and eighty feet.

At one locality, Independence, the Corniferous limestones are succeeded upward by a blue shale, which here forms the base of the Hamilton, and which, from its order of sequence, we would consider to be the equivalent of the "Marcellus Shales" of eastern sections, although differing in some respects, in its lithological and biological characters, from them.

The beds of this serial are somewhat variable, lithologically, consisting of thin bands of concretionary limestone, and dark blue, argillaceous, fine-grained shales, which are highly charged with bituminous matter, and interlaminated by seams of coal, from one-eighth to one-fourth of an inch in thickness. This shale weathers, on exposure, to a light blue clay, and contains an abundance of fossil shells, a few species of corals and cerinoid remains; while some of the beds hold numerous remains of land plants (*Lepidodendron* and *Sigillaria*).

[1] This Division has been referred, by Rev. Dr. Barris, to the Upper Helderberg, and its thickness estimated at nearly one hundred feet, ("Local Geology of Davenport and Vicinity.") Proceedings of Davenport Academy of Science, VOL. II, 1880. This formation has also been referred to the Corniferous, by Mr. A. S Tiffany, (Geology of Scott County, Iowa, and Rock Island County, Illinois, etc., 1885.)

This division represents an old shore deposit, and carries, in its fauna and flora, evidence both of its terrestial and marine origin; and marks, as well, the dawn and culmination of terrestial vegetation of the old Devonian time, in Iowa.

The thickness of this division is probably thirty feet or more, although only about twenty-five feet have actually been observed.

These shales, which represent only a *local* sub-division of the Hamilton, were first recognized by Mr. D. S. Deering, of Independence; and subsequently described by Prof. S. Calvin, as "Some Dark Shales Below the Devonian Limestone at Independence, Iowa" (Bulletin of U. S. Geological Survey, Vol. IV., No. 3, 1878.)

In this publication, the statement was made (p. 726) "That the shale in question is not a mere local deposit, but is distributed all along the outcrop of the Devonian Rocks of Iowa."

An extended study of all the Devonian rocks of this State, and the record of numerous borings along its Eastern outcrop, and at other points, has failed to adduce any evidence of the existence of this formation at other localities.

One of the highest members of the Hamilton, in its Eastern extension, is a soft, friable, brownish-yellow sandstone, which is well shown as it out-crops on Pine Creek, some distance above "Pine Creek Mill." This stratum of sandstone here forms a bold escarpment or cliff, about forty feet in height, is obliquely and discordantly stratified throughout, dips rapidly in a southerly direction, and is, so far as observed, devoid of fossils.

At Independence, the blue shales (equal Marcellus Shales) are succeeded upward by heavy bedded, sometimes indistinctly stratified dove-colored and buff limestone, and intrusive beds of shale, with a thickness of twenty-one feet. The lower portion of the limestone here is indistinctly stratified, but is often crossed diagonally and irregularly by seams which cause it to split into uneven slabs and fragments.

As we recede to the West and Northwest from the attenuated Eastern outcrop of the Hamilton, the rocks overlying the blue shales are seen to rapidly increase in thickness, until, on the Wapsipinecan River, only one and one-half miles from the exposure of blue shales they are seen to attain an estimated thickness of sixty-five feet; while on the same stream at Littleton, ten miles to the Northwest, the same rocks are observed to attain a slightly greater thickness.

The following is a partial list of the species occurring at this horizon :

The rocks of the lower portion of the Hamilton are generally heavier bedded, more compact, and uniform in texture, and usually a more pure limestone than those of the upper portion The prevailing color of the strata of this horizon, is blue, and bluish-gray.

In the northern portion of Johnson County, (for instance, at the "State Quarry," Robert's Ferry, Solon, etc.,) occurs a bed of peculiar grayish-white limestone, nothing like it being known to exist in other portions of the State.

This bed has a thickness of from six inches to six feet, or more, is very crystalline throughout, and is made up, to a considerable extent, of broken shells of different species of Brachiopoda, some of which are not known to occur elsewhere in Iowa.

For convenience in subsequent allusion, this bed is here designated the *Shell Bed.*

Underlying this shell bed is a stratum of very hard, fine-grained, blue brecciated limestone.

This limestone is observed at various localities in this portion of the State, and is known to extend as far North as Raymond Station, in Black Hawk County.

The upper portion of this division is made up, for the most part, of thin bedded magnesian and common limestone, and soft, impure, calcareous, argillaceous and silicious, shales and sandstones, of a prevailing grayish-buff color.

In the Eastern portion of Floyd County, some beds of shale, occupying a considerable area, are extensively sun-cracked ; this indicating an elevation of the sea-bottom here, and the exposing of it for some time to etheral conditions and the burning rays of the sun.

The extreme upper portion of this division is almost everywhere, a hard, fine-grained, and brittle, grayish or dove-colored limestone, and singularly devoid of organic remains.

Immediately succeeding the limestone, in portions of Floyd, Cerro Gordo and Worth Counties, and constituting the highest member of the Hamilton group in the State, is a stratum of stiff blue clay, varying from twenty to twenty-five feet in thickness.

This formation, which is entirely devoid of organic remains, may be best seen as it outcrops on Lime Creek and Willow Creek, in Floyd and Cerro Gordo Counties, particularly at Rockford, Hack-

berry, and a locality three miles west from Mason City, on Willow Creek.

This serial, judging from its lithological character and order of sequence, appears to be the equivalent of the "*Genesee Shales*" of the New York section, and to which division we would here refer it.

As we have before intimated, the base of the Hamilton, represented by the blue Shales at Independence, carries a rich Fauna, and evidence, also, of the former existence of a rich, and perhaps varied, flora, which was restricted to this zone.

Of the fossil species occurring in this serial, the following may be enumerated :

Strophodonta arcuata	Strophodonta variabilis
Strophodonta calvini	Strophodonta canace
Strophodonta reversa	Orthis infera
Atrypa reticularis	Atrypa hystrix
Spirifera subumbonata	Rhynchonella ambigua
Gypidula munda	Productus dissimilis
	Lepidodendron and Sigillaria

Also several other undetermined species of Brachiopoda, and corals, and one or two species of crinoids.

Of the above list of species, only two, *Atrypa reticularis*, and *A. hystrix*, are known to occur in the Corniferous limestones below, while only three or four forms are at present known to extend upward into the middle Hamilton, (the shales, limestone, etc., lying above the blue shale and below the blue clay).

The two species *Atrypa reticularis* and *A. hystrix*, as they occur in the overlying rocks, assume a form so altered as to be as readily distinguished as if they were distinct species. The number of blue shale species which occur in the shales at Rockford, is greater than those of all the other divisions combined. A peculiar feature of this blue Shale Fauna, is the depauperation of most of its species.

As to the flora of this division, it is, as we have before stated, indigenous to it ; none of the other serials containing any evidence of the former existence of either terrestial or marine plant life.

The rocks of the middle Hamilton carry a rich and varied fauna, more particularly in its lower and central portions.

Athyris vittata
Atrypa hystrix
Aulopora serpens
Aviculopecten pecteniformis
Calceocrinus clarus
Cladopora lichenoides
Cladopora fisherii
Platyceras rectum
Platyceras auriculatum
Crania bordeni
Cryptonella planirostra
Cyathophyllum davidsonii
Cystiphyllum americanum
Phacops bufo
Discina media
Stromatopora alternata
Gomphoceras lunatum
Megistocrinus latus
Meristella haskensii
Monticulipora monticula
Orthis iowensis
Orthis livia
Paracyclas ohioensis
Pentamerella dubia
Favosites hamiltonensis
Platyceras ammon
Platyceras argo
Platyceras bucculentum
Platyceras cymbium
Spirifera aspera
Spirifera ziczac
Spirifera raricosta
Spirifera subvaricosa
Spirifera subattenuata
Spirifera fimbriata
Spirifera mucronata (*rare*)
Spirifera formosa
Streptorhynchus chemungensis
Strophodonta demissa
Zaphrentis exigua
Atrypa reticularis
Aulopora conferta
Aviculopecten parilis
Chonetes pusilla
Chonophyllum ponderosum
Cladopora romerii
Platyceras symmetricum
Platyceras cymbium
Platyceras bucculentum
Crania hamiltonensis
Cryptonella rectirostra
Cyathophyllum scyphus
Heliophyllum halli
Discina doria
Discina seneca
Stromatopora incrustans
Leiorhynchus alta
Megistocrinus farnsworthi
Meristella meta
Euomphalus cyclostomus
Orthis vanuxemi
Paracyclas lirata
Pentamerus comis
Philipsastrea gigas
Favosites niaulus
Platyceras tetis
Platyceras conicum
Platyceras carinatum
Platyceras erectum
Spirifera raricosta
Spirifera tullia
Spirifera varicosa
Spirifera subumbonata
Spirifera pinnata
Spirifera parryana
Spirifera mannii
Spirifera euruteines
Terebratula romingeri
Stromatopora incrustans

In places these rocks contain a rich fish fauna, as well as numerous new and described species of shells, corals, etc., which are not at present known to occur in the rocks of any other area.

The mingling of the lower and upper (Chemung) Devonian faunas is here greater than in any of the other divisions of the rocks of this age in the State.

The grouping of Fossils of the middle Hamilton, differs considerably at different localities; although not to such an extent as has been heretofore generally supposed. The lithological character of the beds of the middle Hamilton, are usually very variable, so variable, indeed, as to make it a matter of great difficulty, and often an impossibility, to trace any particular bed for any considerable distance by this character.

Some portions of the strata of this horizon, as at Charles City and Independence, are traversed by more or less regular wave-like undulations.

The thickness of the Corniferous and Hamilton rocks vary somewhat in different portions of their area.

According to the record of the boring of the artesian well at Cedar Rapids,[1] the thickness of the Corniferous and Hamilton strata is, at that place, shown to be 380 feet.

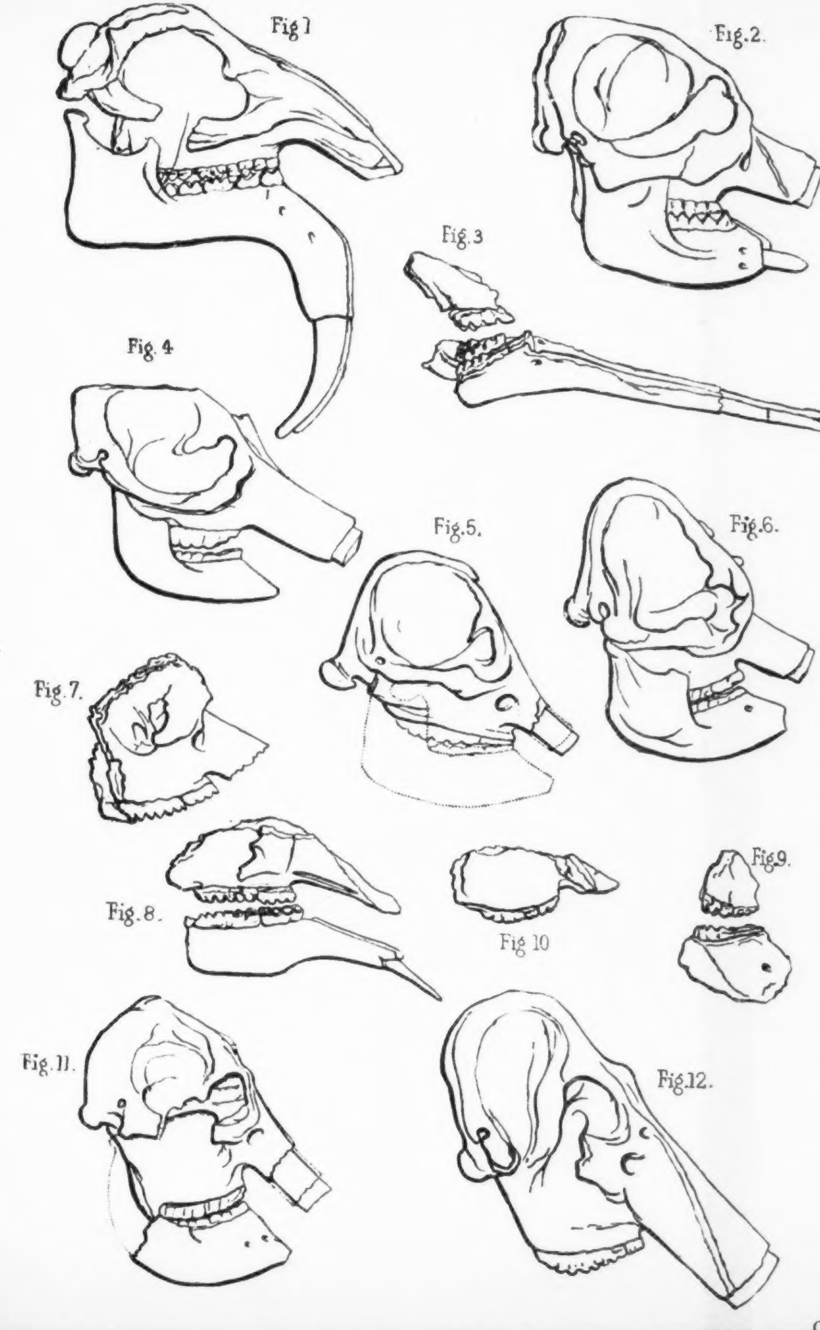
Adding to this thirty feet, for the blue shales at Independence, and fifty feet (estimated thickness) for the Hamilton rocks (including the blue clay at Rockford etc.) lying above the highest beds of the Cedar Rapids section, we have an aggregate thickness, of the rocks of the Corniferous and Hamilton groups in Iowa, of 430 feet.

Succeeding the Hamilton, in the northwest portion of its area, is the highest division of the rocks of this age in the State.

This serial, which is plainly a sequent of the Hamilton, is known to attain a thickness of forty-five feet, and is made up, for the greater part, of a yellowish brown argillaceous, and sometimes slightly arenaceous, shaley limestone, which weathers to a stiff yellow, sometimes light buff, clay; and in places contains considerable numbers of ferruginous concretions. These shales are sharply defined, both serially, lithologically, and palaeontologically, and are a vast repository of beautifully preserved fossil remains; a large majority of which are peculiar to them.

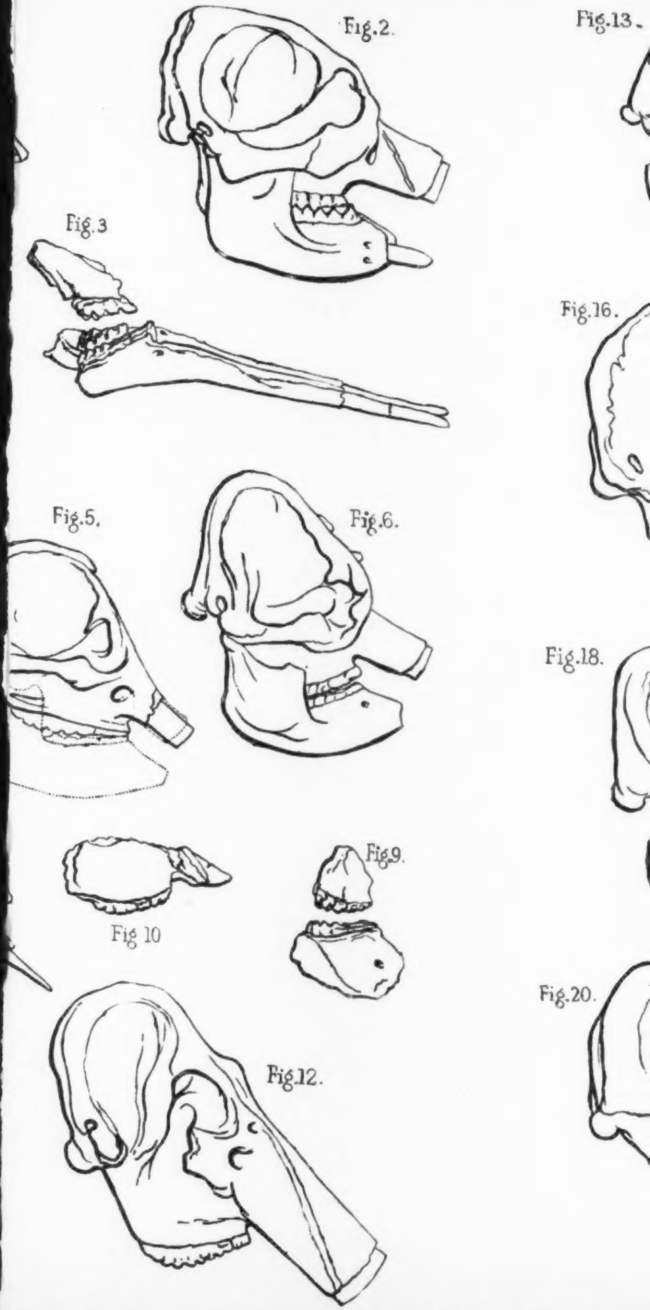
[1] We are under obligations to C. J. Fox, Esq., superintendent of the Cedar Rapids Water Co., for a record of this boring, together with samples of the rocks (2225 feet) passed through.

PLAT



Crania of

PLATE XVI.



Crania of Proboscidia.

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VI.

ig.13.

Fig. 13a.

Fig. 14.

.16.

Fig. 15

Fig. 17.

18.

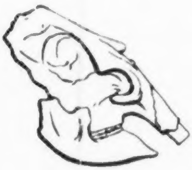

Fig 17a

Fig. 19

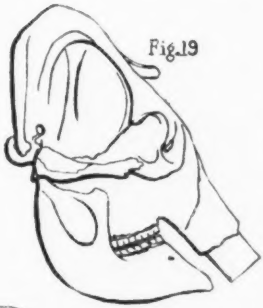

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Fig. 19b.

Fig. 19a

a.

This formation carries *two* faunas ; one at the base, and another occupying the remainder of the division.

The fauna at the base is represented by considerable numbers of very minute, and finely preserved Brachiopoda, Gastropoda, Crustaceans, Foraminifers and Corals, a large number of which are as yet undescribed.

Not more than one or two of the forms, occurring at the base of the shales, are known to occur outside this formation.

Of the described species of this fauna, the following may be enumerated.

Athyris minutissima. C. L. Webster.
Platystoma mirum. Webster.
" pervetum. Webster.
Naticopsis rarus. Webster.
Turbo strigillata. Webster.
" incerta. Webster.
Holopea tenuicarinata. Webster.
Cyclonema brevilineatum. Webster.
" subcrenulatum. Webster.

For a more detailed description of this fauna etc., reference may be made to a paper on "Description of New Species of Fossils From the Rockford Shales of Iowa," which appeared in the November number of this Journal for 1888.

Of some of the described species which constitute the fauna of the higher horizon, and which are mostly typical of it, the following may be given.

Rhynchonella subacuminata. Webster
Paracyclas sabini. White.
" validalinea. Webster.
Atrypa reticularis.
" hystrix.
" " *var* planosulcata. Webster.
" " *var* elongata. Webster.
Spirifera whitneyi
" hungerfordii.
" strigosus. Meek, (*S. orestes*, H. and W),
" substrigosus. Webster.
" norwoodii. Meek, (*S. cyrtinaeformis*, H. and W).
" fimbriata.
" macbridei.

Smithia fohnanni.
" multiradiata.
Stromatopora incrustans.
" expansa.
" solidula.
Caunopora planulata.
Fistulipora occidens.
Alveolites rockfordensis.
Aulopora iowensis.
" saxivadum.
Zaphrentis solida.
Campophyllum nanum.
Chonophyllum ellipticum.
Cystiphyllum mundulum.
Spirorbis arkonensis.
" omphalodes.
Acervularia inequalis.
Callonema lichas.
Stromatopora alternata.
Crania famelica.
Strophodonta arcuata.
" reversa.
" demissa.
" canæ.
" variabilis.
Productus dissimilis.
Streptorhynchus chemungensis..
Orthis iowensis.
Leiorhynchus iris.
Terebratula navicella.
Cryptonella salvini.
Naticopsis giganteum.
Loxonema pexatum.
" crassum. Webster.
" iowense. Webster.
" giganteum. Webster.
Pachyphyllum woodmanii.
" crassicostatum. Webster.
" ordinatum. Webster.
Pachyphyllum crassum. Webster.

Platystoma lineatum.
Ambocoelia umbonata.
Productella truncata.

Aside from the foregoing enumeration, we have in our cabinet, large numbers of undescribed forms. Two-thirds or more, of the species which constitute the fauna of this horizon, are not known, at present, to occur outside of it.

When species, common to the shales, occur in any of the rocks below, and when fossils, peculiar to the lower groups, extend upward into the shales, they usually appear under a form, so altered that specimens from the different formations may be distinguished as readily as if they were distinct species.

About one-third of the species of the upper shale fauna occur in other divisions of the Devonian of this area, as well as most other areas of North America; and very closely allied forms also occur in the European strata of this age (see description and figures of fossils in the geology of Russia and the Ural mountains etc.; also Walcott's Monograph, Palaeontology of the Eureka District, U. S. Geological Survey, 1884, and U. S. Geological Survey of Fortieth Parallel, Vol. IV; as well as a paper by H. S. Williams, "On a remarkable Fauna at the base of the Chemung group of New York," American Journal of Science, February, 1883).

For a more detailed description of this formation, and its faunas, reference may be made to the following preliminary reports, which appear in various numbers of this Journal for 1888. "Notes on the Rockford Shales," and "Description of new species of Fossils from the Rockford Shales of Iowa," also "Contributions to the knowledge of the Genus Pachyphyllum," and "Description of new and imperfectly known species of Brachiopoda from the Devonian rocks of Iowa;" as well as to a paper on "A description of the Rockford Shales of Iowa." which is accompanied by a map of the area occupied by the shales, that appears in Vol. V. of the Proceedings of the Davenport Academy of Science.

From the description of this formation here, and in previous preliminary reports, it will be seen in reality, to constitute a *new and distinct group of strata*, carrying *two* rich and varied faunas; but which has not heretofore been recognized as such, and which is not developed in any other area in North America, or Europe; although *all* contain links of evidence which demonstrate its Devonian age.

For this group of strata, heretofore provisionally designated by us as the "Rockford Shales," we would propose the name *Hackberry Group*, from Hackberry, in Cerro Gordo county, Iowa, where the most extensive and typical exposure of this formation isobserved.

In our forthcoming Monograph on the Devonian formation of Iowa, alluded to in a former paper ("Description of new species of Fossils from the Rockford Shales of Iowa," this Journal for November, 1888) a detailed description of the rocks of its several divisions, together with a list of all the Fossil species known to occur in them, will be given.

CONCLUSIONS.

It is thus shown, 1st, that the type section (Iowa) of the central continental area, differs materially from the type sections of other areas of North America.

2d. That there were nearly or quite as striking alterations of conditions during the successive deposition of strata in Iowa, as are indicated at the east, and that the rocks of this section are separable into well-marked natural divisions and subdivisions, not heretofore generally recognized as such.

3d. That the Devonian rocks of Iowa, instead of attaining a thickness of only one hundred and fifty feet to two hundred feet, as given by previous writers, are now known to attain an aggregate thickness of four hundred and seventy five-feet.

4th. That the Corniferous limestone is developed in Iowa to a thickness varying from one hundred and eighty feet to two hundred feet, and carries a fauna which is, to a great degree, peculiar to this stage.

5th. That the Corniferous limestone is succeeded upward by shales, limestones, clays, and sandstone of the Hamilton group.

6th. That the base of the Hamilton is marked, locally, by a thirty foot stratum of Blue Shales, carrying a peculiar fauna and flora which represents the "*Marcellus Shales*" of eastern areas, but which has not been heretofore so recognized.

7th. That what has been designated, by most writers on the subject, as Corniferous, Hamilton, and Chemung, limestone, sandstone, and Shales, does in reality represent the *Middle* Hamilton.

8th. That the upper portion of the Hamilton, in the northwest portion of its area, is represented by a stratum of blue clay from twenty to twenty-five feet in thickness, which, though devoid of Fossil remains, yet represents, in its order of sequence, the "*Gen-*

esee Shales" of eastern sections; and the present writer is the first to recognize it as such.

9th. That in the Iowa section is represented (so far as is at present known) the extreme western, attenuated, representatives of the eastern "*Marcellus Shales*" and "*Genesee Shales.*"

10th, That the upper Hamilton (blue clay) is succeeded upward by a stratum of Argillaceous Shales, which everywhere occupy the highest position in the Devonian series in the State, and has an observed thickness of forty-five feet; although known to have attained a greater thickness prior to the glacial period, during which time they were more or less extensively eroded.

11th. That these Shales, which have been designated (provisionally) by the writer, in all his preliminary reports, as the "Rockford Shales," constitute, lithologically, stratigraphically, and biologically, a *new* and heretofore unrecognized (as such) group of strata, and which is not developed in any other area in North America, or Europe; although *all* contain links of evidence which demonstrate its Devonian age, and for which the writer has in this report proposed the name *Hackberry Group.*

EDITOR'S TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

The Philadelphia Academy of Natural Sciences has recently attacked the problem of original research in a practical manner. For many years the activity of the institution was restricted to the publication of work produced by scientific specialists on material contained in their own collections, and in the museums of other institutions. To this function it subsequently added that of giving instruction to classes in the natural sciences. We have often pointed out that the former line of activity is not enough for an institution which at one time was the only academy of original research in this country; and we have also expressed the opinion that the teaching of the natural sciences to classes of beginners, is not one of its proper uses. We have schools for teaching elsewhere, but

academies of original research are too few for any one of them to be diverted from its proper object.

Recently the management of the Academy has undertaken some explorations in the Bermuda Islands, and the results are coming into print. Large collections of Invertebrata were made, and reports on these by Professor Heilprin are being published in the Proceedings. These embrace much matter of interest, and illustrate what can be done with a moderate outlay in regions not remote. The recent appropriation by the State of Pennsylvania of $50,000 to the institution comes at a favorable period for advancing this excellent work. There are various ways in which this can be done. Our own belief has been and still is, that the best possible use for money at the present time is the endowment of some of the professorships which are as yet unoccupied. The most important agency in original research is men of ability and energy. They can be relied upon to obtain material more cheaply and effectively than persons not familiar with specialties. And these men should be members of the governing body of the Academy, ex-officio.

In case the Academy should adopt such measures the wealthy citizens of Philadelphia cannot better advance the general intelligence as well as the reputation of their community, than by sustaining them by material aid. A new wing should be added to the present building, with improved facilities for work and better light in some of its departments than the present building affords. The new wing should be erected for a smaller sum than the old one cost.

At its April meeting the United States National Academy of Sciences elected officers for six years; elected five new members, and some foreign correspondents; and conferred the Watson and Draper medals. Most of the old officers were re-elected, a new Vice-President (Prof. S. P. Langley), and a new member of the council being exceptions. In reelecting the incumbent of the office of President, the Academy made a mistake which it cannot afford. This is to be regretted, as the

Academy is not as well known in the country as it should be, and of course it is important that when and where it is known, nothing should detract from the respect with which its acts should be regarded. No organization allied to the Government can expect to escape the pressure of interests involved, but it is an omen of evil when the interests of persons override the interests of science and of the Academy. The majority of the Academy has not in this instance the excuse of ignorance, and one is lead to fear that not a few of their number deliberately approve of methods that bring science into disrepute, and justify reflections on that country and on that society where they are not only tolerated, but rewarded.

The American Society of Psychical Research has made an appeal for money with which to carry on its work. We hope that this appeal will meet with a prompt and abundant response. The society has done a great deal of excellent work, and the field before it is an immense one. The subject of its researches is of the greatest interest, both scientific and popular, and its importance cannot be overrated. The manner in which its work has been done is worthy of the highest praise, and the country cannot afford to let it languish for want of the necessary assistance. When we consider the comparatively small outlay necessary to the production of its results, we think the endowment of the society one of the most worthy objects that can attract the attention of the liberal.

RECENT LITERATURE.

PLOWRIGHT'S UREDINEÆ AND USTILAGINEÆ.[1]—Students of the fungi may well rejoice that at last we have a book in the English language which discusses with some fulness the structure, biology and classification of the Rusts and Smuts.

[1] *A monograph of the British Uredineæ and Ustilagineæ*, with an account of their Biology including the methods of observing the germination of their spores and of their experimental culture, by Charles B. Plowright, F. L. S., M. R. C. S. [etc.] Illustrated with woodcuts and eight plates. London. Kegan Paul, Trench & Co., 1 Paternoster Square. 1889. 8vo. x., 348 pp.

In this volume, the author, who has long been favorably known as a student of the Rusts more particularly, takes up the various parts of his subject in the following order. viz., Biology of the Uredineæ; Mycelium of the Uredineæ; Spermogonia and the so-called Spermatia; Æcidiospores; Uredospores; Teleutospores; Heterœcism; Mycelium of the Ustilagineæ; Formation of the Teleutospores of the Ustilagineæ; Germination of the Teleutospores of the Ustilagineæ; Infection of the Host-plants by the Ustilagineæ; Spore-Culture; The Artificial Infection of Plants. After this follow the systematic portions including nearly two hundred pages of generic and specific descriptions.

Descriptions, synonymy and references to literature and exsiccati are well worked out. All measurements (which are very generally given) are in micromillimetres. Many biological notes are given after the descriptions, thus adding much to the value of the work.

The genus Uromyces is subdivided as follows into artificial subgenera:

I. Euuromyces: A.	Auteuuromyces	represented by	11	species.
B.	Heteruromyces	"	4	"
II. Brachyuromyces,		"	0	"
III. Hemiuromyces,		"	6	"
IV. Uromycopsis,		"	3	"
V. Micruromyces,		"	4	"
VI. Lepturomyces,		"	0	"
Making a total of			28	species.

The genus Puccinia is similarly subdivided:

I. Eupuccinia: A.	Auteupuccinia	represented by	23	species.
B.	Heteropuccinia	"	20	"
II. Brachypuccinia,		"	5	"
III. Hemipuccinia,		"	14	"
IV. Pucciniopsis,		"	3	"
V. Micropuccinia,		"	19	"
VI. Leptopuccinia,		"	12	"
Making a total of			96	species

The remaining smaller genera are represented as follows:

Triphragmidium—2 species; Phragmidium—9 species; Xenodochus—2 species; Endophyllum—2 species; Gymnosporangium—4 species; Melampsora—17 species; Coleosporium—4 species; Chrysomyxa—2 species, and Cronartium—1 species. In addition there are descriptions of imperfect forms as follows: Uredo—11; Cæoma—6; Æcidium—21. There are thus descriptions of 167 genuine species, and 38 imperfect forms.

In the Ustilagineæ the genera are represented by species as follows: Ustilago—21; Sphacelotheca—1; Tilletia—3; Urocystis—9; Entyloma—7; Melanotænium—1; Tubercinia—2; Doassansia—2; Thecaphosa—2; Sorosporium—1. The allied and associated species, viz., Graphiola—1; Entorrhiza—1; Tuberculina—1, and Protomyces—5, are added as a supplement, bringing the total of Ustilagineæ up to 57 species. The whole number of descriptions in the book is two hundred and sixty-two.—*Charles E. Bessey.*

RECENT BOOKS AND PAMPHLETS.

Baxter, Sylvester—The Old New World—Salem, 1888. From the Hemingway Archæological Expedition.

Blytt, A.—The Probable Cause of the Displacement of Beach-lines. From the author.

Branner, John C.—The Cretaceous and Tertiary Geology of the Sergipe-Alagôas Basin of Brazil. Transactions of the American Philosophical Society, Vol. xvi, 1889. From the author.

Broom, R.—On a Monstrosity of the Common Earth-worm, *Lumbricus terrestris L.* Transactions Natural History Society, Glasgow. From the author.

Brongniart, Charles—The Fossil Insects of the Primary Group of Rocks. Read before the Manchester Geological Society, Oct. 6, 1885. From the author.

Ellis, Havelock—Women and Marriage, or Evolution in Sex. From the author.

Fewkes, J. W.—On the emission of a colored fluid as a possible means of protection resorted to by Medusæ. Extract Microscopist. From the author.

——— —On the serial relationship of the ambulacral and adambulacral plates in the Star Fishes. Extract Proceedings Boston Society Natural History. From the author.

Hitchcock, C. H.—Recent Progress in Ichnology. Proceedings of Boston Society Natural History, Vol. xxiv. From the author.

Lewis, T. H.—The "Old Fort" Earthworks of Greenup County, Kentucky. Reprint from American Journal of Archæology, Vol. iii, Nos. 3 and 4. From the author.

Lewis, T. H.—Stone Monuments in Southern Dakota. Extract from the American Anthropologist, April, 1889. From the author.

Loomis, Elias—Relation of Rain-areas to Areas of High and Low Pressure. American Journal of Science, Vol. xxxvii, April, 1889. From the author.

McGee, W. J.—Classification of Geographic Forms by Genesis. Reprint from National Geographic Magazine, Vol. i, No. 1. From the author.

Moreno, P. Francisco—Informe preliminar de los Progresos del Museo la Plata, durante el primer semestre de 1888. Presentado al señor Ministro de Obras Publicas de la Provincia de Buenos Aires.

Mourlon, M.—Sur la découvert, a Ixelles (prés-Bruxelles), d'un Ossuaire de Mammifères, antérieur au diluvium. Extrait de Bull. de l'Acad. roy. de Belgique, 3d série, tome xvii, No. 3, pp. 131 and 134, 1889. From the author.

Newton, E. T.—Vertebrata of the Forest-Bed. Extract from Geological Magazine, April, 1889. From the author.

Pelseneer, Paul—Sur la valeur morphologique des bras et la composition du systèms nerveux central des Céphalopodes. Extract Arch. Biol., 1888. From the author.

Penrose, R. A. F.—The nature and origin of deposits of Phosphate of Lime. Bull. U. S. Geological Survey, No. 46. From the author.

Shufeldt, R. W.—Osteology of Circus hudsonius. Extract Journal Comp. Medicine and Surgery, 1889. From the author.

Walcott, C. D.—The Taconic System of Emmons. Extract American Journal Science. From the author.

Welling, James C.—The Law of Malthus. Extract from the American Anthropologist, January, 1888. From the author.

Williston, S. W.—The Sternalis Muscle. Proceedings of the Philadelphia Academy of Natural Sciences. From the author.

Winslow, Arthur—The Construction of Topographic Maps by Reconnoissance Methods. From the author.

Wolterstorff, W.—Die Amphibien Westpreussens. Separat Abdruck aus den Schriften der Naturforschenden Gesellschaft in Dantzig, N. F. vii Bd. 2 Heft. 1889. From the author.

GENERAL NOTES.

GEOGRAPHY AND TRAVEL.[1]

AFRICA; BORELLI'S TRAVELS IN GALLA-LAND.—Sr. Borelli has surveyed portions of the country to the south of Abyssinia. Mount Harro (3,150 metres) and the Dendigrons of which it forms a part, form the watershed between Hawash, the Abai (Nile) and the Omo or Ghibie. The explorer went to Kiffan in the Kingdom of Gomma, and accompanied the king to Giren the capital, and to the summit of Mount Maiguddö (3,300 m.) whence the mountains of Culld, Centab, Aruzulla, etc., were seen and their positions ascertained. He then went to the Peak of Ali, to the market Cornbi, and to the cascade of the Ghibie, 40 metres high. Then traversing the desert between Gimma and Giangerò, he attempted to visit Mount Borguda where it is said that human sacrifices are offered on the first of every month but was attacked by the lancemen of Giangerò, and compelled to fly. Afterwards he visited the river Omo with the idea of passing south of the town of Vallamo to Cuccia, but was hindered by the king of Gimma. Another attempt to reach Borguda was defeated by the Giangerò, so, traversing the country of Abalti, he entered that of the Daddalé, and then returned to Antoto, whence he started for Zeila on the 9th October last.

The Giangerò are neither Musselmen nor Christians, yet adore a single spiritual indefinable god, to whom they sacrifice with knives at the first moon of every month 47 males who always belong to two honored families. All the Giangerò, by an operation performed when young, have but one testicle, and cut their hair that they may not appear women.

The river Omo does not turn to the east, as shown on all maps, but at 5° N. lat., bends westward and then turning southward falls into a lake or rather extensive marsh, known as Sciambara. This information was derived by Sir Borelli, from the testimony of more than 100 merchants in the habit of traversing the country in caravans. These merchants also asserted that the Omo leaves Lake Sciambara at its southern extremity, and ends by sinking under ground near a very large lake, which Borelli believes to be the Victoria. Thus the Omo may be the true source of the White Nile.

[1] This department is edited by W. N. Lockington, Philadelphia.

EUROPE; THE KOPIAS SEE.—HERR SUPAN (Petermann's Mitteilungen III. 1889.)—gives an account of the Kopias See, in the Bæotian mountains of Greece, and of the works undertaken since 1883 by the engineer Pochet for its reclamation In the above mentioned mountains are three basins, the Kopias, Likeri and Paralimni, all of which are permanenly or periodically filled by lakes which drain into the sea through the earth. The largest of these is the Kopias See which extends northward in two bays and westward is continuous with the wide valley of the Kephissos. Near the edge of this lake and not above twenty metres above its level, lie the ruins of Thebes and Livadia. The Kephissos and many other streams fall into these basins, and as the rainfall of the region varies greatly at different seasons and in different years, so does the level of the waters of the lake, thus banishing cultivation from any spot within several metres in height of the lowest level. In 1852 and 1864 even the ruins of Livadia were covered. Yet in the oldest period of Grecian history the kingdom of Minyas with its capital Orchomenos, occupied the sight of the Kopias, and in three spots traces of the canals and other works made to control the waters may be seen. The modern works consist of a ring-canal and an inner canal. These canals unite in the eastern bay of the lake, and the united canal is carried by a succession of cuttings and tunnels through the Likeri and Paralimini lakes into the sea.

GEOGRAPHICAL NEWS.—The greatest known depths of the various oceans are thus given by Dr. Supan (Petermann's Mitteilungen, III. 1889).

North Pacific Ocean	44° 55′ N. lat.	152° 26′ W. long.	8513 metres.
South Pacific "	24° 37′ S. "	175° 0 W. "	8101 "
North Atlantic Ocean	19° 39′ N. "	66° 26 W. "	8341 "
South Atlantic "	0 11″ S. "	18° 15′ W. "	7370 "
Indian Ocean	9° 18″ S. "	105° 28′ E. "	5852 "

THE archives of Savona, a city not far to the west of Genoa, Italy, prove that the family of Christopher Columbus lived at that city about 1470.

AT the coming Paris Exhibition there is a globe 40 metres in circumference, that is, upon a one-millionth scale. All the regions will thus be represented with their correct curvature. This globe will not be so large as that of Mr. Wyld, which for a long time disfigured Leicester Square, London, but will have

the advantage in truthfulness, since Mr. Wyld's globe showed the various countries upon the interior surface, and therefore with a concave instead of a convex curvature.

Out of the total population of 46,855,704 of the German Empire on Dec. 1, 1885, 22,933,664 were males and 23,922,040 females. As regards religion 29,369,847 were returned as evangelicals, 16,785,734 as Catholics, 563,172 as Israelites, and 125,673 as of other Christian creeds.

The population of Bulgaria and Roumelia on January 1, 1888 was found to be 3,154,375, including the Russians, Servians, Germans, French, etc., sojourning in the country. The Bulgarian race includes 2,336,250 individuals. The Turks in the two countries number 904,000, with a curious predominance of the feminine sex, which counts 607,000. The same preponderance of females is observable in the Greeks, who number 56,000 females against 28,000 males. Among the Bulgarians and other races the male sex is in excess.

Soundings recently taken from the English ship Rambler in the Chushan archipelago near the Chinese coast, have proved the existence of submarine rocks which rise to a metre or even half a metre of the surface. These lie between 30°-3′-25″ and 30°-21′ N. lat, and 122°-12′ and 122°-25′25″ E. longitude.

British New Guinea is divided into three sections, a western, from the Dutch boundary to the river Aixd, a central extending from the Aixd to the island of London in about 144°-15′ E. long. and an eastern which includes all the Lyonisiades to Rossel. A recent report of Sir John Douglas gives an account of all recent explorations.

In his account of his ascent of Mount Kibo (Kilimanjaro) Otto E. Ehlers states that the tracks of an elephant were visible in the snow at a height of 5,000 metres together with tracks of buffaloes and antelopes. The last traces of vegetation were also found at the same elevation, (*Petermann's Mitteilungen*, III. 1889).

Asia.—The Present Flora of Krakatoa.—M. Treub, who arrived at Krakatoa, June 19, 1886, gathered near the

coast the seeds or fruits of sixteen species of plants, and upon the mountain, eight species of flowering plants, and eleven of ferns.' Four of the phanerogams were composites. When it is remembered that all plants previously existing upon the island perished in consequence of the heat of the eruption, and that the whole island was at that date covered with a thick layer of scoria, the existence of a new flora is surprising proof of the part played in plant-colonization by currents, wind, and birds. All the species found upon the coast, except *Gymnothrix elegans*, a grass which is very common in Java, are identical with those colonizing species which are found in recent coral islands. Only two of the mountain species were identical with those of the coast. As regards the number of individuals, M. Treub says, "three years after the eruption, the new flora of Krakatoa is composed almost entirely of ferns. The phanerogams occur insolated here and there." Yet the soil is not at all favorable in its composition for the growth of ferns, which have been preceded by two species of mosses and six of algæ, the decay of which has furnished aliment to the ferns which in their turn prepare the ground for the phanerogams.

THE ISLAND REUNION.—According to M. A. Blonde (*Bull. d. l. Sociéte dé Géographie*) the island of Bourbon, or, as it is now called Reunion, discovered in 1545 by the Portuguese Mascarenhas, and taken possession of by France in 1649, is of elliptical form, its greater axis running N.W. and S.E., and its greatest length and width being 71 and 57 kilometres respectively. The island is entirely volcanic, and seems to have been formed by a volcano originally situated at the N.W extremity, but which was displaced southward until it finally reached the S.E. extremity, where it is still in activity. The route of this volcano is marked by extinct craters ranged symmetrically on both sides of the axis, the principal those of Mufate, Ciloss, and Salazie. From these great circles spring the three great torrents of the island, the rivers Galets, St. Etienna, and Midi. These are separated by high mountains, among which are Grand-Beirard, 2,970 metres, Cimandef 2,250, Pitore de les Neiges, 3,069, and Salago, 2,150 m.

NEW GUINEA.—According to Prince Roland Bonaparte the share of Holland in New Guinea has an area of 382,000 sq. kilometres, that of England 230,000, and that of Germany 232,000. The last includes 52,000 sq. kil. of smaller islands,

which are now known as the Bismarck archipelago, while the German portion of the mainland has received the title of Kaiser Wilhelm-Land. Another brochure of the same writer gives maps of the Gulf of Huen (New Guinea), according to Fleuriece, D'Entrecasteaux, and Mosely, also a corrected map from the recent explorations of Finsch and Von Schweinitz.

CAPT. BINGER'S JOURNEY.—Capt. Binger, who, two years ago, undertook a journey of exploration from Bamaka towards the Gold Coast, has been heard from, his last letter being dated Salagha, Dec. 11, 1888. M. Binger encountered great difficulty in leaving the territory of Lamery. It was his proposition to study carefully the mountains whence the Joliba takes its source, and it was arranged that so soon as he gave notice of his arrival at Kong, a victualling party should march along the Akka from Grand-Bassam to relieve him. In March, 1888, M. Binger reached Kong. From Kong, M. Binger proposed to make an excursion to Xendi, returning to Kong by the Gottogo. The French residents of the Slave Coast, having heard of the arrival of a white man at Salagha, sent a messenger to him, who brought back an answer in which M. Binger stated that, leaving Salagha the next day and, repassing Kong, he trusted to reach Grand-Bassam in April, 1889. The ease with which the communication was sent from the Slave Coast, (Grand Popo and Agoue) shows that Kong is more accessible from this part than from the Gold Coast.

GEOLOGY AND PALÆONTOLOGY.

AN INTERMEDIATE PLIOCENE FAUNA.—Mr. Geo. C. Duncan sent me a collection of remains of Mammalia from a lake deposit in Oregon which has an interesting character. The list of species is short, and but few of them are determinable. It is as follows:

Canis sp.
Elephas or *Mastodon.*
Holomeniscus or *Auchenia.*
Aphelops sp.
Hippotherium relictum sp. nov.
Equus sp.

These bones do not resemble in color those from near Silver Lake, Oregon, which are black. They are yellowish brown or light brown, like those from the locality in Whitman Co., which were recorded in the last number of the NATURALIST. The interest of the list consists in the fact, that it represents the first time a fauna which contains at the same time the large true horses and lamas, and the three-toed horses and Aphelops rhinoceros. The latter forms belong to the Loup Fork horizon, and the former to the Pliocene, and they have not been found hitherto in association in the Rocky Mountain Region. The fauna described from Florida, by Leidy, is probably of Loup Fork or Upper Miocene age, and the mammalia are similar to or identical with those of the same horizon in Kansas and Nebraska.

This fauna represents an older period than the Upper Pliocene of Silver Lake, and may be, very probably, the contemporary of that of the Pliocene lake of Idaho, from which I have described numerous species of fresh-water fishes. The deposits containing them I called the Idaho beds (Proceedings Academy Philadelphia, 1883 p. 153), and they may be regarded as representing the middle or lower Pliocene. The new Hippotherium is characterized as follows:

Represented by two superior and three inferior molar teeth. The grinding surface is nearly square, and the crown is short, and moderately curved. The section of the internal style is a wide oval, and it presents no angle or point of approximation to the protoconic crescent, and conversely none to the posterior column. The latter has the usual connection with the hypoconic crescent, but projects as far inwards as the anterior area, and is well defined. The enamel-boundaries are quite simple. The usual loop of the posterior inner border of the anterior lake is rudimental in an anterior true molar, and in the last molar it is small and subround. No isolated loop. A single short process of the border towards the internal column. Cementum abundant.

Dimensions of superior molars, No. 1; diameters of grindface; transverse, 19 mm.; anteroposterior, 16 mm. No. 2; transverse, 19 mm.; anteroposterior, 18 mm.—*E. D. Cope.*

STORMS ON THE ADHESIVE DISK OF ECHENEIS.—In a paper published in the *Annals and Magazine of Natural History* for July, 1883, Mr. Storms endeavors to solve the different questions pertaining to the structure and morphological inter-

pretation of the adhesive disk of Echeneis, and closes with the following remarks suggested by *Echeneis glaronensis*:

"1. As to the position in classification of the genus Echeneis;

"2. As to the general form of the body of *Echeneis glaronensis* as compared with that of living species.

"1. Authors have classed this genus in various families of Acanthopterygians. Joh. Müller makes of it a group of the Gobiidae; L. Agassiz and, after him, most authors class them with the Scombridæ.

"Certainly none of the characters of *Echeneis glaronensis* point toward the Gobiidæ; on the contrary, in the shape of the head, the structure of the ventrals, the size of the pectorals, the shape of the caudal fin, etc., it differs more from the Gobiidæ than the living forms do. On the other hand, by all these characters and others, *Echeneis glaronesis* ought to be classed among the Cotto-Scombriform Acanthopterygians. But here the difficulty begins. If we adhere strictly to the characters of the families given by Dr Günther, *Echeneis glaronensis*, on account of the number of its vertebræ (10+13 according to Dr. Wettstein,) should be classed among the Carangidæ, whilst all the living forms having more than 10+14 vertebræ ought to be put with the Scombridæ. The other characters of *Echeneis glaronensis* do not determine in which of the two families it ought to be placed.

"2. A careful comparison of the proportions of all the parts of the skeleton of the fossil Echeneis with those of the living forms, such as *Echeneis naucrates* or *Echeneis remora*, shows that the fossil differs nearly equally from both, and that it was a more normally shaped fish than either of these forms. The head was narrower, and less flattened, the preoperculum wider, its two jaws had nearly the same length. The ribs, as also the neural and hæmal spines, were longer, the tail more forked, and the soft dorsal fin much longer. In fact it was a more compressed type, probably a far better swimmer than its living congeners, as might be expected, if the smallness of the adhesive disk is taken into account."

It is evident from the above description of Dr. Storms that the *Echeneis glaronensis* represents a genus distinct from the existing forms of the family. This new genus may be named Opisthomyzon, from the fact that the sucking disc is more posterior in position than in the living forms.—*E. D. Cope.*

SKETCH OF THE GEOLOGY OF SPAIN.—The *Reseña Geographica y Estadistica* of Spain, issued during the past year, contains an introductory article upon the geology of the peninsula by D. Juan Bisso. During the Cambrian age the surface of Spain presented a multitude of isles and islets, composed in great portion of igneous rocks, but containing also stratified crystalline strata. The principal island, already quite extensive, occupied the greater part of Galicia, the north of Portugal and small portions of the present provinces of Caceres, Salamanca, and Zamora. Another isle occupied the eastern portion of the present Castilian provinces of Avila, Segovia, and Toledo. A great number of islets were strewn in what is now the southern part of Portugal, Estremadura, and north-western Andalucia. Toward the North arose some points in the line which eventually became the northern Cordillera. Later on, at the close of the Cambrian, the important slate deposits of the Pyrenees arose above sea-level, together with portions of Estremadura, and of the southern Andalucian mountains.

Throughout the Silurian and Devonian periods the main island increased considerably, so that at the commencement of the Carboniferous, it occupied all Galicia, the west of Asturias, and the provinces of Leon and Zamora, its southern line running by Ledesma, Salamanca, Sepulveda, and Siguenza, and then turning south in an irregular curve so as to embrace, in the same mass, the sites of Madrid, Toledo, Cuidad Real and Alcarez. Its most southerly extension reached the Sierra Morena, and its western coast extended to Oporto. At the same period a great part of the Pyrenees had emerged, as well as many islands, in Catalonia, between Burgos and Soria, in western Aragon and eastern Castile. In the south parts of the Sierra Nevada and the extreme south-east of the peninsula had appeared. Permian strata have not been, with certainty, met with in Spain.

In the Triassic period the principal mass already extended much to the southeast, and in Portugal and Huelva had almost reached its present limits, comprehending Seville and Cordova in its southern extension. In the northeastern it occupied all of Oviedo and Leon, Zamora and Salamanca, great part of the provinces of Valencia and Santander. The Pyrenees formed a zone as now; almost all the southeastern islands united forming a tract occupying great part of the present provinces of Murcia, Almeria, Granada and Malaga.

The Jurassic seas must have occupied but a small extent, since at the conclusion of the Triassic, the greater part of

the present peninsula had emerged, including part of the Basque provinces, eastern Castile and northern Andalucia, while the remainder of Andalucia was occupied by many islands.

Subsequent submergence made the Cretaceous seas larger,the eastern coast of the principal mass receding to the line of Santander, Reinosa, Burgos and Segovia, while a gulf extended in the north from Santander almost to Oviedo, and the Pyrenees were partly submerged. Yet in the same period the islands of Aragon and the eastern part of Castile became united into a peninsula, joined to the mainland by a narrow Isthmus at Avilar. This peninsula extended southward to the Sierra Albarracin. At the same time the islands between Burgos and Calatayud became united into one, those along the coast from Gerona to Fortora also joined, and those of Murcia became united to the great southeastern island.

At the end of the Cretaceous period the peninsula was completed almost as it now stands, except that the sea covered the entire basin of the Ebro, penetrating between the islands of the coast from Gerona to Murcia (again partially submerged) and through passes opened in the Pyrenees. There was also a narrow lake in the center of Galicia. During this period immense nummulitic deposits accumulated in the Ebro basin, until the sea finally shallowed into a series of lakes, which in Eocene times filled up with a different series of deposits.

In Miocene times, the sea penetrated only between the Murcian and Andalucian islands, into the basin of the Guadalquivir, in the north at some points in Galacia, and along a narrow zone on the eastern coast. Lakes still existed in the basin of the Ebro, and also through most of the provinces of the Castilles and Leon. In Portugal a number of smaller lakes occupied much of the area about Leiria, Lisboa, Evora and Castro-Verde.

In the Pliocene age the sea still penetrated by various points, especially into the valley bed of the Guadalquiver. Many small deposits occur in the valleys. All that the Post-pliocene has done has been to fill up various depressions with extensive diluvial and alluvial deposits.

MINERALOGY AND PETROGRAPHY.[1]

PETROGRAPHICAL NEWS.—The serpentine of Montville, N. J., occurs in veins and as isolated nodules in crystalline dolomite, and also as a thin coating on irregularly rounded masses of a gray crystalline pyroxene, with the chemical and optical properties of diopside. The examination of thin sections across the contact between the enclosing serpentine and its nucleus of pyroxene shows conclusively that the former is the direct product of alteration of the latter. In almost all cases the resulting serpentine is found to be slickensided and grooved as if it had been shoved along against some hard substance, and had thereby suffered planing. The origin of the pressure producing this shoving is thought by Mr. Merrill[2] to be the increase in volume which the pyroxene undergoes in its change to serpentine. Even when the alteration is complete and no trace of the original pyroxene remains, the origin of the serpentine through the hydration of some magnesium mineral is shown by the crowding of the calcite grains associated with the serpentine into broad fan-shaped masses. Analyses of the pyroxene core and serpentine surrounding it substantiate the conclusions reached by the microscopic study of thin sections.

	SiO_2	MgO	CaO.	Al_2O_3	Fe_2O_3	FeO	Ign.
Pyroxene	54.22	19.82	24.71	.59	.20	.27	.14
Serpentine	42.38	42.14		.07	.97	.17	14.12

From the fact that no veins of quartz are to be found in the serpentine, it is thought that sufficient magnesium was furnished by the dolomite to change all of the silica of the pyroxene into serpentine.—The ophiolite from Thurman, Warren Co., N. Y., is observed by the same author[3] to have originated in the same manner as the serpentine from Montville. In this case, however, the original pyroxene occurs in little grains and concretionary masses scattered through calcite.—The rocks to the north of Lake Bolsena in Italy consist principally of trachytes, according to Klein,[4] and those to the south of a leucite bearing series. The former include olivinitic and non-olivinitic varieties in different members which the amount of plagioclase varies largely. The leucite rocks embrace tephrites, basanites and leucitophyres. The first two contain porphy-

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Maine.
[2] Proc. U. S. Nat. Museum. 1888. p. 105.
[3] Amer. Jour. Sci. March. 1889. p. 189.
[4] Neue Jahrb f. Min., etc., B. B. vi p. 1.

ritic crystals of leucite, augite, plagioclase, sanidine, magnetite, apatite, hauyne, nepheline and more or less olivine in a groundmass composed of microlites of leucite, augite and plagioclase, and a very little glass. According to the predominance of one or the other of the constituents they are divided into basaltic, doleritic and tephritic varieties, and these are further subdivided into olivinitic and non-olivinitic sub-varieties. To the northeast of the Lake there is an augite-andesite with a zonal plagioclase in which the different zones possess very different extinction angles. The paper in which these rocks are described contains a fine series of analyses.—An interesting occurrence of basic concretions in the granite of Mullaghderg, County Donegal, Ireland, is described by Hatch.[1] The rock is a dark, coarse-grained, sphene-bearing, hornblende-granitite containing microcline, orthoclase and oligoclase. Sections of orthoclase nearly parallel to the orthopinacoid are traversed by two sets of strongly refracting markings parallel to the cleavage lines. The markings are due to the deposition of a mineral with an extinction of 14° in the formerly existing cleavage cracks. In this granite are flattened spheroids of three or four inches in diameter, which consist of a reddish granite nucleus and a zonally and radially developed periphery composed of plagioclase, magnetite and a little brown mica. A resumè of the literature of spheroidal granites is given and a classification of the spheroids is attempted.—A second[2] paper on the dyke rocks of Anglesey is occupied with a description of the diabases and diabase porphyrites of the islands of Anglesey and Holyhead, England. A hornblende-diabase from a large dyke running along the east side of Holyhead Mountain contains a large amount of apatite, and augite crystals that have been enlarged by the addition of original hornblende material.[3]—Dr. Bonney[4] regards the isolated masses of green sandstone occurring in the sand pits near Ightham in Kent, England, as having originated *in situ* by concretionary action. The individual grains are connected together by chalcedony and quartz, the latter forming a fringe around each one of the grains and the latter filling in the remaining interstices.—Dr. Hatch[5] records the analysis of a microgranitic keratophyre from near Rathdrum, County Wicklow, Ireland.

[1] Quart. Jour. Geol. Soc. 1888. p. 548.
[2] Cf. AMERICAN NATURALIST, 1888. p. 453.
[3] Harker: Geol. Magazine, 1888. p. 267.
[4] Geol. Magazine, 1888. p. 297.
[5] Geol. Magazine, Feb. 1889. p. 70.

The rock consists almost exclusively of a microcrystalline groundmass of quartz and albite in which are a few porphyritic crystals of the latter mineral. These are sometimes broken up into patches divided by narrow seams of feldspathic substance with an extinction different from that of the albite. The analysis yielded :

SiO_2	Al_2O_3 Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ign.
77.29	14.62	tr	.38	.16	7.60	.57

—Gonnard[1] mentions pyrite, oligoclase, emerald, garnet, beryl, calcite, chlorophyllite, apatite and tourmaline as accessory constituents of the gneiss occurring along the banks of the Saône near Lyons, France.—Kloos[2] has examined the thin sections of rocks that have been subjected to great artificial pressure, and finds in them no signs of mineral crushing. He advises care in ascribing to pressure the crushed appearance of minerals in rocks. He is inclined to regard the phenomenon as due to increase in volume under chemical change.—A typical picrite occurring in boulders near St. Germans in the Liskeard District in Cornwall, England, is mentioned by Bonney[3] as containing augite which has been changed successively into brown and green hornblende, and colorless needles of the same mineral, while the original form of the augite has remained. —Glaucophane has been discovered by the same author[4] as a secondary product of augite in a diabase occurring in a block in the Val Chisone, Cottian Alps.—Aggregates of topaz, a little feldspar, kaolin and mica have been found by Salomon[5] in a granular quartz rock (one variety of the greisen) resulting from the silicification of the granite at Geyer in Saxony.—The green-sand from just above the chalk beds in Kent, England, is composed[6] of grains of quartz, flint, feldspar, glauconite, magnetite, spinel, zircon, rutile, tourmaline and occasional grains of garnet, actinolite, epidote and chalcedony.—An eclogite from near Frankenstein in Silesia consists essentially[7] of omphacite and a calcium garnet. The omphacite contains inclusions of smaragdite, and portions of the garnet have passed over into zoisite through the loss of calcium and the assumption of water.

[1] Bull. Soc. Franç. d. Min. XII. p. 10.
[2] Zeits. d. deutsch. geol. Gesell. XL. 1888. p. 612.
[3] Min Magazine, Oct. 1888. p. 108.
[4] Min. Magazine, Dec. 1887. p. 191.
[5] Zeits. d. deutsch. geol. Gesell. XL. p. 570.
[6] Miss. Gardiner: Quart. Jour. Geol. Soc. Nov. 1888. p. 755.
[7] Traube : Neues Jahrb. f. Miner., etc. 1889. I. p. 195.

Mineralogical News.—*New Minerals.—Dahllite*[1] occurs as a yellowish white incrustation on red apatite from the Odegärden mine at Bamle, Norway. It is found in little fibres with a density of 3.053 and a composition as follows :

CaO	FeO	Na_2O	K_2O	P_2O_5	CO_2	H_2O
53.00	.79	.89	.11	38.44	6.29	1.37

corresponding to $4(Ca, Fe, Na_2, K_2)_3(PO_4)_2 + 2 CaCO_3 + H_2O$. Before the blowpipe the mineral decrepitates without fusing. It is uniaxial and negative.—*Eudidymite*[2] is found in tabular crystals in the elaeolite syenite of Langesundfiord at Aro, Norway. It is a white mineral with an easy basal cleavage, a hardness of 6, and specific gravity of 2.553. It is minoclinic with $a : b : c = 1.7107 : 1 : 1.1071$ and $\beta = 86° 14' 27''$. The plane of its optical axis is the clinopinacoid. The acute bisectrix is inclined 58½° to c in the acute angle β. $2Va = 29° 55'$ for yellow light, and the dispersion is inclined with $\rho > \upsilon$ Its analysis yielded :

SiO_2	BeO	Na_2O	H_2O	
72.19	11.15	12.66	3.84,	corresponding

to Na. H. Be. Si_3 O_8.

—*Lansfordite* is a white mineral resembling calcite. It is described by Genth[3] as forming stalactites 20 mm. in length in an anthracite coal mine at Lansford, Schuylkill Co., Pa. Its composition is $MgO = 23.18$ per cent, $CO_2 = 18.90$ per cent, $H_2O = 57.79$ per cent, $= 3 MgCO_3 + Mg(OH)_2 + 2 H_2O$. Its hardness is 2.5, and specific gravity 1.692.—*Rare Minerals.*—Messrs. Diller[4] and Whitfield have identified the blue mineral present in fibres penetrating the quartz and plagioclase of the pegmatoid portion of a biotite gneiss at Harlem, N. Y., as *dumortierite.* In thin section the mineral is seen to have a cleavage parallel to $\infty \bar{P}\infty$ and a second parallel to some prismatic plane. It contains long tubular cavities parallel to the vertical axis and is frequently polysynthetically twinned parallel to some plane in the prismatic zone. It has a hardness of 7, and specific gravity of 3.265. The analysis of a specimen of the mineral obtained from a rock composed principally of dumortierite and quartz, from Clip, Arizona, yielded :

[1] Brögger and Bäckström: Oefv. af. Kongl. Vetenskaps Akad. Förh. Stockholm. 1888. No. 7.
[2] Brögger: Nyt. Magazin for Naturv. XXX. II. p. 196.
[3] Genth: Zeits. f. Kryst. XIV. p. 255.
[4] Amer. Jour. Sci. Mch. 1889. p. 216.

SiO_2	Al_2O_3	MgO	B_2O_3	P_2O_5	H_2O
27.99	64.49	tr.	4.95	.20	1.72

equivalent to $3\ Al_8\ Si_3O_{18} + Al(BO_3)_2 + 2\ H_2O$. Damour,[1] who first analysed the mineral regarded it as a simple silicate of aluminuium of the formula $Al_8\ Si_3\ O_{18}$.—Additional observations upon *bertrandite* increase materially our knowledge of this rare mineral. Investigations by Urba[2] upon the crystals coating the faces of feldspar from Pisek, Bohemia, and the walls of cavities in this mineral yield results analogous to those obtained by Penfield[3] in the case of the Mt. Antero crystals. According to Urba $a : b : c = 7191 : 1 : 4206$. In addition to the cleavage parallel to $3P\bar{\infty}$ Urba finds also a very perfect one parallel to oP. The new plane $\frac{4}{9}\ P\breve{\infty}$ is also discovered. Analysis of the Pisek mineral gave: $SiO_2 = 49.90$, $BeO = 42.62$, $H_2O = 7.94$. The Mt. Antero crystals[4] are bounded by the three pinacoids. Of the two basal planes one is flat and the other rounded in consequence of an oscillatory combination with a brachydome. The distribution of the electrical properties of the crystals show them to be hemimorphic, as indicated by the oscillatory combination on one only of the basal planes. The mineral has recently been discovered at Stoneham, Maine. Mr. Penfield[5] has examined crystals from this locality and has identified on them the planes oP, $\frac{1}{2}\ P\bar{\infty}$, $3\ P\breve{\infty}$, $\infty P\breve{\infty}$, and $\infty\ P\breve{3}$. The crystals are double wedge-shaped, are hemimorphic in the direction of their vertical axis, and are elongated parallel to the brachy-axis. One twin with oP as the twinning plane was observed. A calculation of the axial ratio gave $a : b : c = .5973 : 1 : .5688$.—Pisani[6] has analysed *cupro-descloizite* from Zacatecas, Mexico and has found in it:

Vd_2O_5	As_2O_5	PbO	CunO	ZnO	H_2O
17.40	4.78	53.90	8.80	11.40	3.20

The mineral has a brown color on a fresh fracture, and a specific gravity of 6.06.—A new analysis of the very remarkable mineral *melanophlogite* has been made by Pisani.[7] The mineral was found in iittle colorless cubes associated with calcite, sulphur and celestite in a limestone geode from near Girgenti, Sicily. After purifying as carefully as possible it yielded:

[1] Bull. Soc. Min. d. France. IV. p. 6.
[2] Zeits. f. Kryst. XV. p. 194.
[3] Cf. AMERICAN NATURALIST. 1888. p. 1023.
[4] Penfield. Amer. Jour. Sci., Mch. 1889. p. 210.
[5] Ib. p. 210.
[6] Bull. Soc. Franç. d. Min. XII. p. 38.
[7] Bull. Soc. Franç. d. Min. Dec. 1888 XI. p 298.

SiO_2	SO_3	$Fe_2O_3\ Al_2O_3$	Loss.
91.12	5.30	.43	1.52.

—*Kröhnkite* ($CuSO_4 + Na_2SO_4 + 2H_2O$) from Chili, is monoclinic, according to Darapsky[1] with $a : b : c = 1 : 2.112 : 0.649$. $B = 64° 8'$. Its hardness is 2.5, and specific gravity, 1.98.

BOTANY.[2]

THE TREATMENT OF EXSICCATI IN THE HERBARIUM.—Whether exsiccati should be kept as they are published, or cut up and distributed in the Herbarium, is a question of sufficient importance, it seems to me, to warrant a brief consideration. Exsiccati are generally arranged arbitrarily, and unless well indexed, are often labyrinths to those who are unfamiliar with them. Those which have a separate index to each fasciculus are bad enough, but, unfortunately, many of the largest and best sets have no index at all, and those whose indexes are published separately are continually outgrowing them. If distributed in the herbarium, the specimens are always at hand, and a student does not need to examine indexes to see whether a given species is in such or such a set, but can find all the specimens from every set together in the herbarium, thus saving time and patience, and making comparison of specimens more easy. Much of the synonomy becomes in time forgotten and obsolete, and many exsiccati are for this reason almost useless. But if distributed, the synonomy of each specimen can be kept up with the times by means of labels on the sheet on which it is mounted, and thus many specimens made useful which otherwise would be of but little value for reference.

The common objection to cutting up and distributing exsiccati is that it destroys their identity. But in most exsiccati the name, etc., is printed on the label of each specimen, and if not, these labels can easily be stamped. References to exsiccati are, as a rule, by number, but if distributed, the specimens can be found by name without the number, and when found the number is with them to show that they are the specimens referred to. Besides, if distributed, they can be found by many who have not noticed these references.

[1] Neues Jahrb. f. Min., etc. 1889. I. p. 192.

[2] This department is edited by Professor Charles E. Bessey, Lincoln, Neb.

A strong objection, however, to cutting up exsiccati is found in cases where species are described in them, and the exact dates of the descriptions are wanted. These dates are generally given on the covers of the fasciculi, and are, of course, lost if the set is cut up and the specimens distributed. This can be partially remedied by preserving these covers, as the number of each specimen will indicate to which one it belongs; and this one objection is certainly overcome by the manifest advantages of wider usefulness, greater convenience of reference, and saving of time otherwise spent in determining synonomy.—*Roscoe Pound.*

ANEMONE CYLINDRICA GR. WITH INVOLUCELS.—Last year, in running over some Nebraska plants from Lincoln, with Mr. Pound, we noticed undoubted specimens of *Anemone cylindrica* Gr., with one or two peduncles bearing two leaved involucels. Further examination of numerous specimens collected in the same vicinity at different times shows this peculiar feature to be of quite common occurrence. The leaves of the involucels are similar to those of the involucre.

Authors, in characterizing this species, describe the peduncles as naked; it is remarkable, then, that this peculiarity should occur so commonly.

It may be a hybrid with *A. dichotoma* L., which is provided with an involucel, and occurs here commonly.—*H. J. Webber.*

POLYGONUM INCARNATUM ELL. WITH FOUR-PARTED PERIANTH.—A form of *Polygonum incarnatum* Ell. is found commonly in the vicinity of Lincoln, Neb., having the perianth four-parted instead of five-parted as always described. On most heads, however, a few flowers may be found having the normal five sepals. *P. incarnatum* belongs to the section Persicaria Tourn., characterized as having a five-parted perianth. *P. virginianum* L., belonging to the section Tovaria Adans., which has the perianth four-parted, is found in the same vicinity. It is the *only* other four-sepaled species occurring.—*H. J. Webber.*

INFECTION OF THE BARBERRY; HOW PERFORMED.—Let us suppose that we wish to perform the classical infection of the barberry with *Puccinia graminis.* In the autumn, six young barberries, small enough to be covered with a bell-glass, having been planted, as soon as their leaves are fully developed in the spring, they may be infected in the following manner: A quantity of *Puccinia graminis* having also been provided in the autumn, and kept during the winter in

the mode before explained,[1] as soon as the barberry foliage is ready, test the germination power of the *P. graminis* by placing a few fragments in water in a watch-glass. If it germinate freely and produce a good crop of mycelical spores, as proved by microscopic examination, the contents of the watch-glass may be at once employed. It is best to do your infection experiments in the evening. Water one of the barberries freely, through the nose of a watering-can, and then cover it with a bell-glass ; then water the outside of the bell-glass. By so doing, the temperature of the enclosed air is reduced, and the inside of the bell-glass, as well as the leaves of the barberry become bedewed with condensed vapor. After leaving it a few minutes, remove the bell-glass and apply the germinating spores with a camel-hair pencil. As the promycelial spores easily become diffused in the water in the watch-glass, by stirring it with the camel-hair pencil the water becomes equally charged with them ; then by simply brushing the water on the leaves you may be pretty sure of successfully infecting the plant. Replace the bell-glass and give it another douching outside with the watering-can. If sufficient material has been prepared, each alternate barberry may be infected in the same manner. The bell-glass need not be kept over the infected plants more than two or three days. If the weather be very bright, the bell-glasses should be shaded by putting a piece of matting or carpet over them to prevent the foliage being scorched by the sun. In the course of eight or ten days the yellow spots, on which the spermogonia are produced will appear, and in two or three weeks the perfect æcidiospores will be developed. It will then be seen that only those barberries to which the spores were applied have the æcidiospores on them, while the alternate plants remain free. If an attempt be made to infect a plant in the daytime, when the sun's rays are full upon it, it will be found that the water all runs off the leaves ; but by operating in the evening, in the manner directed, the leaves are bedewed with a thin layer of moisture, and no difficulty will be found in applying the spore-charged water.—*C. B. Plowright, in Monograph of Uredineæ and Ustilagineæ.*

A TRUE FIELD MANUAL OF BOTANY.—The publishers announce that they will bring out an edition of the new revision of "Gray's Manual," with narrow margins, and with limp cover binding, for field use. As this will bring the book

[1] Bundles of straw containing teleutospores are to be collected in the autumn, and kept out of doors during the winter, so that they may be subjected to the same vicissitudes of temperature and moisture as would happen to them in a state of nature.

down to a pocket size, every teacher ought to insist upon this edition for use in his botanizing classes. It is understood that the revision will include the plants of the prairies, and of the great plains up to the eastern limits of the region covered by "Coulter's Manual," *i. e.*, about the 100th meridian. —*Charles E. Bessey.*

DISTRIBUTION OF KANSAS FUNGI.—Dr. W. A. Kellerman and Mr. W. T. Swingle, well known mycological students of Manhattan, Kansas, have undertaken to make a distribution of Kansas fungi. The first fascicle consists of twenty-five species very neatly put up, with printed labels. The species represented are the following:

Aecidium aesculi E. & K. *Aecidium dicentrae* Trelease. *Ceratophorum uncinatum* (Clinton) Sacc. *Cercospora cucurbitae* E. & E. *Cercospora desmanthi* E. &. K. *Cercospora lateritia* Ell. & Halsted. *Cercospora seminalis* E. & E. *Gloeosporium apocryptum* E. & E. *Gloeosporium decipiens* E. & E. *Melasmia gleditschiae* E. & E. *Microsphaera quercina* (Schw.) Burrill. *Peronospora arthuri* Farlow. *Peronospora corydalis* DeBary. *Phragmidium speciosum* Fr. *Puccinia emaculata* Schw. *Puccinia schedonnardi* Kell. & Sw. *Puccinia* (*Leptopuccinia xanthii*) Schw. *Ramularia virgaureae* Thuem. *Roestelia pyrata* (Schw.) Thaxter. *Scolecotrichum maculicola* E. & K. *Septoria argophylla* E. & K. *Septoria speculariae* B. &. C. *Sphaerotheca phytoptophila* Kell & Sw. *Uredo quercus* Brondeau. *Ustilago zeae mays* (DC.) Winter.

ZOOLOGY.

THE NERVOUS SYSTEMS OF ANNELIDS AND VERTEBRATES.—Mr. John Beard analyzes in a recent number of *Nature* the Annelidan features found in the development of the Vertebrate nervous system, and adds some points of his own. He claims that the spinal ganglia arise not from the neural ridges but from the adjacent ectoderm, and in such a manner as to justify their comparison with the parapodial ganglia described by Kleinenberg in Lepadorhynchus. Again, the two halves of the neural plate are separated at an early stage by a median groove of ciliated epithelium, and therefore the nervous system is ontogenetically paired. This ciliated groove ultimately furnishes the epithelial lining of the neural

canal, and except the fact that in the annelids the ciliated groove is not invaginated, the resemblance is thus rendered very close.

THE ORIGIN OF THE VERTEBRATE PELVIS.[1]—Professor Weidersheim presents the following hypothesis of the origin of the Vertebrate pelvis. The *inscriptiones tendineæ* of the ventral myocommata which are immediately below the posterior limbs, develop cartilage, and unite on the middle line, forming the simple median pubis of the Lepidosirenidæ and of the Urodele Batrachia. In the Ceratodontidæ this pubis has a short lateral process which is directed upwards and backwards. In Lepidosirenidæ this process is much more elongate, and is derived from a metamorphosis of the tissue of the myocomma. At its distal (superior) end it passes into fibrous connective tissue. This is the cartilaginous beginning of the ilium, which in most Batrachia and in higher Vertebrata reaches the vertebral column.

A BOY WITH A TAIL.—The *Naturaliste*[2] gives a figure (from a photograph) and a description of a boy who lives near Saigon, who has a tail about eight inches long. It originates at the usual point, but contains no vertebræ. The extremity is bent outwards, like the horizontal part of a crank. The boy has also a mammiform enlargement on each buttock. He is about twelve years of age.

ZOOLOGICAL NEWS.—ECHINODERMS.—L. Cuénot (*Arch. Zool. Exp. et Gen.*, 1888) details the anatomy of several brittle stars. While many of his statements do not well admit of abstract, it may be noticed that he finds, not hæmoglobin as has been reported, but a colored ferment, which converts peptones into albuminoids.

Ludwig (*Zeitsch. wiss. Zool.*, xlvii, 1888) describes *Ophiopteron elegans*, a brittle star which apparently has the power of swimming ; while in the same number Brock has a revision of the Ophiurids of the Indian Archipelago.

WORMS.—Völtzkow (Semper's *Arbreten* viii.), investigates *Aspidogaster conchicola*, which is familiar as a type of the trematodes in Huxley's "Invertebrata." The egg undergoes total segmentation and is enclosed by a cellular membrane, as in other Trematoda. The penis, vulva, receptaculum vitelli,

[1] Bericht. d. Natu-forsch. Gess. Freiburg, i. e., Bd. IV., Heft. 3.
[2] No. 48, March, 1889.

etc., are ectodermic, but the internal generative organs are of mesodermic origin. The young forms pass into the stomach of the mussel, from which it works its way into the pericardium and kidneys of the host. The details of the adult structure are given.

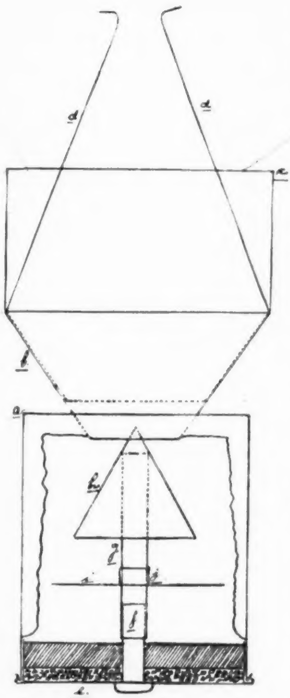
At the meeting of the Linnean Society of New South Wales, Nov. 28, 1888, Mr. J. J. Fletcher described twenty new species of Australian earthworms, twelve belonging to the genus *Cryptodrilus*.

MOLLUSCA.—The land-shell, *Subulina octona* Chem., hitherto regarded as peculiar to the West Indies, has been found in a coffee plantation in New Caledonia. Its introduction is as yet unexplained.

ENTOMOLOGY.

AN INSECT TRAP TO BE USED WITH THE ELECTRIC LIGHT.—Some experience in collecting insects at the electric lights last summer led me to the conclusion that a simple piece of apparatus, which could take the collector's place, when he was forced to go home to steal a few hours for sleep, would be a boon to the insect-hunter. Having once gained the idea I at once endeavored to realize it, with the following result:

I obtained a three-quart tin pail, represented by *a* in the accompanying drawing, about six and one-half inches long by five and a half in diameter, and had a tinner cut out of the bottom a three-inch circle. Then taking a funnel six inches and a half in diameter at its widest part my tinsmith cut off the smaller end so as to leave an opening at this end of two and a quarter inches in diameter. This frustrum of a hollow cone, *b* in the drawing, is then soldered fast to the bottom of the pail *a*, the flaring end being outward and the smaller end projecting within the pail a half inch or more. A flat, hexagonal piece of tin, *c*, was next made to fit the funnel, *b*, and, after being carefully adjusted so as to stand vertically across the center of the mouth of the funnel, was firmly soldered in this position. Two pieces, *dd*, of steel spring, No. 8 wire, were then fastened to opposite sides of the funnel. These wires when pressed together at the top will pass into the small opening in the bottom of the globe of the U. S. Electric Light Co.'s lamp, and when released from pressure will spring back to their normal po-



sition and the projecting ends will rest upon the inner surface of the globe, and thus furnish a means of support for the apparatus. The lid of the pail, *e*, which forms the bottom of the trap, has soldered to its inner face a cylindrical tube of two inches or a little less in length; between this tube and the rim of the lid is put first a layer of crystals of potassium cyanide and over this a half-inch layer of plaster of Paris, which should be carefully smoothed down and then moistened with sufficient water to form a hardened crust over the top a quarter of an inch or a little more in thickness. The lid will have to be supported in the mouth of the pail in some way similar to that illustrated by the working drawing. Finally, a cylindrical tube, *g*, four and one-half inches long is made just large enough to fit snugly over the tube, *f*, and a hollow cone, *h*, with a diameter of three and a height of two and one-half inches is fastened to its top. If it is thought desirable a disk, *i*, about four inches in diameter, with a collar, *j*, may be made to slide up and down the tube *g*.

The whole inside of this trap, except the lower face of the hollow cone, *h*, should be painted black to allow the prey as little light as possible to aid them in making their escape; and the cone, *c*, should be thickly pierced with small holes one inch from the top. It is also well to varnish both sides of the vertical plate, *c*, the inside of the funnel, *b*, and the upper surface of the hollow cone, *h*, to make "Facilis desensus Averni." I have substituted glass for tin in the plate, *c*, as this material is probably entirely invisible to insects, they are more likely to heedlessly dash against it, while they may flutter about the bright tin. But it is much more difficult to fasten to the fun-

nel than tin, is easily broken, and I have not been able to see that it is, in practice, superior to tin. Although the action of the trap seems simple enough it may not be amiss to add a few words on this point. The insects that cluster about the electric lights will dash against the vertical plate, *c*, and being unable to obtain a foot-hold easily either upon its surface or that of the funnel, they will be likely to find their way into the inside of the trap, where they are pretty certain to remain, being prevented from escaping by the deadly fumes of the potassium cyanide and the cone, *c*, whose polished lower surface lighted up by the holes mentioned above will attract them away from the single opening.

The disk, *i*, merely serves to keep a portion of the insects separate from the others while they are engaged in their desperate death struggles; it may, however, be farther utilized as a support for a coarse wire screen, which is not represented in the drawing. This screen will serve a useful purpose in allowing beetles and other small insects to escape through it to the bottom of the trap; in this way only can moths be preserved in a fit state for museum specimens. The tube, *g*, can be raised or lowered so as to more or less completely close the opening in the bottom of the funnel and thus shut out all insects larger than a certain size. My limited experience last summer with this trap convinced me that it was of little use for collecting *Lepidoptera*, as they were usually ruined by the *Coleoptera*, which are much less easily overcome by the poison used. I have not tried the wire screen mentioned above, however, and this modification may preserve a considerable number very well. It answers the desired end very well indeed, however, for all the other orders, and it is especially useful in collecting small *Hemiptera*, *Neuroptera*, *Diptera* and *Hymenoptera*. I have frequently found a pint or more of insects in the trap when I came to examine it in the morning after exposure for a whole night.

Many of the forms will of course occur in unwelcome abundance, and the task of looking over the whole mass carefully is no slight one but it pays. I have in a single night taken a few more than a hundred species, and in three consecutive nights as many as a hundred and fifty species, but I have no doubt but that this record can be easily broken if some of my experiment-loving brother or sister entomologists will follow the suggestions offered in this paper.—*Jerome McNeill.*

EMBRYOLOGY.[1]

THE QUADRATE PLACENTA OF SCIURUS HUDSONIUS; OR, THE COMMON RED SQUIRREL.—In 1887, the present writer called attention to the existence of certain vestigiary placental structures developed during the early stages of the mouse, rat and field-mouse, which indicated that the discoidal placental disk of the late stages of fœtal life of these forms had been derived from one, the placenta of which was zonary or girdle-like in form, as in the cat, dog, hyrax, elephant, etc. All of the forms of rodents mentioned, however, possess at a late stage a very distinctly discoidal placenta, the development of which seems to be associated with the so-called *inversion of the germ layers*, which is so marked a feature of their ontogeny, and one also which renders its processes amongst the most specialized and complex known to embryologists. The notice published in September, 1887, as to the persistence of a girdle-like vestige of the decidua continuous with opposite sides of the placental disk, afforded only tentative evidence of the derivation of the discoidal placental from the zonary form. Recently some remarkably conclusive evidence, favoring such a view, has fallen under my observation in fœtuses of the common red squirrel. Mr. J. P. Moore, one of the pupils in the biological laboratory of the University of Pennsylvania, during the latter part of March, brought in a gravid female red squirrel in which two fœtuses were found, *in utero*, which are the basis of the following account.

These fœtuses measured 16 mm. in length from the vertex of the head to the end of the body. The two cerebral vesicels had just appeared as a pair of smooth saccular diverticula from the sides of the anterior end of the neural tube. The spinal cord filled out the vertebral canal entirely, and the two enlargements, brachial and lumbar, were distinctly visible through the integument of the dorsal median line. The limbs were so far developed as to show the digits distinctly differentiated. The stage, in fact, represents one which is very nearly equivalent to that of the human embryo at three months.

The peculiarity of the most importance in the present case, in relation to the question of the origin of the discoidal placenta in other forms, is the unusual shape presented by that organ, which is quadrate in *Sciurus hudsonius*. Both fœtuses

[1] This department is edited by Professor JOHN A. RYDER, University of Pennsylvania, Philadelphia.

were found in one horn. They formed ovoidal swellings of the uterine cornu separated from each other by a slight interval. They were nearly an inch long and not quite three-fourths of an inch in diameter. Upon carefully inserting the point of a scissors through the uterine wall ventrally, and opening it so as to expose the embryo in its membranes, it was found that the latter were not adherent to the mucosa, except over a small quadrate area on the mesometric side. After the placenta was forcibly detached with part of its decidua, the scar left on the uterine wall measured 9 mm. in length over its short diameter which coincides with the direction of the passage in the cornu. Its diameter the other way or transversely to the uterine cornu was 12 mm. The edges of the scar forming its short diameter were slightly elevated so as to form a pair of slight folds projecting above the non-placental area above and below the embryo. These folds represent a very rudimentary decidua reflexa, traces of which are also present in forms with a zonary placentation. The edges of the scar forming the margins of its long diameter pass gradually into the mucous membrane of the uterine walls, and there is no such well-marked fold representing a reflexa as appears on the other sides. The peculiar quadrate form of the placenta was equally manifest in its fœtal part, or that to which the umbilical cord and membranes are attached. The area of the placenta in millimetres is, in round numbers, 9x12 = 108 sq. mm. Over all the remaining portions the fœtal membranes were not attached to the uterine mucosa. There was a strongly developed *decidua vera* over the placental area.

If we now compare this peculiar quadrate placenta with the ordinary zonary type the homologies of its parts will become clear, and I think it affords demonstrative evidence of the direct derivation of this quadrate form from one which was zonary. If, for example, we select the zonary type, as seen in the cat of the third or fourth week of intra-uterine life, and mark off a quadrate portion of the placental girdle which will be as 9 is to 12, 9 being the width of the girdle and 12 the proportional length of a segment of it measured along its curve, we shall have a placenta which is the morphological equivalent of that seen in the red squirrel.

In the rabbit's uterus of the eighth day of gestation there is a proliferation or thickening of the dorsal or mesometric side of the uterine wall, which betrays distinct traces of a squarish figure. As this represents the site of the future placenta in the rabbit it is plain that the squirrel has retained in a far more

pronounced manner traces of the primitive girdle-like placenta. It seems, in fact, as if that portion of the placental girdle directed away from the blood supply had been suppressed, leaving, as in the case of the red squirrel, only a segment of the original zonary placenta on the mesometric side.

This diversity in the form of the placenta, even in types where the uterus is divided into a pair of tubular cornua, is associated with the mode of vascular supply of the uterine walls. In the cat, mouse and rabbit there is present a rich plexus of vessels all round the uterine tube interposed between the outer and inner muscular coats. The mouse has very few uterine glands, the rabbit and cat on the other hand have them very numerously imbedded in the wall of the mucosa. The area where active proliferation of the uterine wall goes on together with hypertrophy of the uterine gland differs greatly in form in different types. In the mouse the hypertrophy is at first mainly confined to the connective tissues of the uterus; in the rabbit, cat and squirrel it is at first mainly associated with changes in the size, form and thickness of the walls of the tubular glands. All of these phenomena in turn are associated with the manner in which the blood supply for the maternal placenta is distributed. If the blood-vascular supply is developed mainly on the mesometric side, there appears to be a tendency to develop a discoidal placenta from the dorsal segment of the uterine mucosa which is in contact with the embryo and its membranes. If the blood-vascular supply of the uterine walls persists around the whole circumference of the tubular horn of the uterus there will be a tendency to develop a girdle-like placenta, as in the cat. If the muscular supply of the uterus opposite the mesometric side is, on the other hand, suppressed to any great degree, the continuation of the placenta fails to be formed on that side, and the quadrate segment of the girdle leading finally to the discoidal form is developed. As I have shown in a former note, that the mode of contact of the tubular uterine wall with the spherical ovum had something to do with the evolution of a zonary type of placentation, it may be well to indicate in this connection that there is also a physiological factor to be considered in the blood supply of the uterus during gestation and the way in which such supply is modified. The factors at work in the differentiation of the placenta in the mammalia may be said to be mechano-physiological in character. The method of the establishment of formal relations between the surfaces of the embryo and parent during fœtal development are purely mechanical. These

primary conditioning factors are further modified by changes in the physiological processes incident to gestation. While these points just insisted upon must be borne in mind in working out a final interpretation of the method of evolution of the various forms of the placenta, the quadrate placenta of the red squirrel appears to be of great significance, as bridging the gap between the discoidal and zonary forms; it plainly shows how the passage from the one to the other was effected. This is all the more interesting from the circumstance that both square and round forms are met with in one and the same order, but in different suborders.

Recently my views as to the origin of the amnion and placenta have been criticized by Minot in the *Journal of Morphology*, ii., pp. 432-434. In reply, it may be said that my theory of the amnion has little in common with that of Van Beneden and Julin, which is the reason I did not cite them. My theory of the origin of the amnion, despite my critic, remains the only one which is tenable. In the same way, my theory of the genesis of the girdle-like placenta is equally safe from annihilation at the hands of morphologists. As I entertain a great respect for a vast mass of data which might be cited in proof of my position, I should be doing less than my duty not to insist upon standing by the latter.—*J. A. Ryder.*

PHYSIOLOGY.[1]

EFFECTS OF STIMULATING NERVE CELLS.—The fact that activity of a gland cell produces in the cell protoplasm changes, which may be recognized by the microscope, has long been known. Not only is the morphological appearance altered, but also the behavior of the cell toward staining reagents. The highly interesting fact that analogous changes accompany the activity of nerve-cells has been discovered by Donaldson and Hodge[2] in the case of the cells of the posterior root ganglia. Korybutt-Daszkiewicz[3] of the Warschau Pathological Laboratory endeavors to advance the subject one step further by showing that the activity of the cells of

[1] This department is edited by Dr. Frederic S. Lee, Bryn Mawr College, Bryn Mawr, Pa.
[2] Cf. *The American Journal of Psychology*, Vol. i, p. 479, 1888.
[3] *Archiv f. mik. Anatomie*, Vol. xxxiii, p. 51, 1889.

the spinal cord affects the staining qualities of the cells. In the frog the sciatic plexuses are laid bare, the nerves are cut, and the central end of the eighth nerve is stimulated at regular intervals for one hour, each stimulation of three minutes being followed by a rest of two minutes. The spinal cord is then removed, hardened, sectioned, and double-stained with hæmatoxylin and safranin. For a control experiment the spinal cord of another frog is, in each case, prepared in exactly the same manner, with the exception of the nerve stimulation. An active and a resting cord are thus obtained for comparison. The nuclei of the cells of the grey matter are colored—some red and some blue-violet. Enumerations give in the control (resting) cord to 1 red, 8.97 blue nuclei; in the stimulated cord to 1 red, 2.71 blue; in the active cord the relative number of red is 3.31 times greater than in the resting one; in parts of the cord lying immediately adjacent to the entrance of the stimulated nerve, the red nuclei are relatively even more abundant. The chemical condition of the nuclei is evidently altered so as to make them more susceptible to the safranin than to the hæmatoxylin. [It is to be regretted that the author apparently enumerates all the cells, even those of the supporting tissue, with the nerve cells.]

GASEOUS EXCHANGE IN THE LUNGS.—Professor Bohr, of Kopenhagen, has recently carried on a series of experiments, the results of which indicate the incorrectness of the commonly received opinion that the passage of oxygen and carbonic dioxide between the air and the blood in the lungs is a process of simple diffusion.[1] By a modification of Ludwig's stromuhr the blood of the carotid artery of a dog was, in its passage, exposed to the air of a closed chamber until equilibrium had been established between the blood and the air; the latter was then analyzed, and the partial pressures of the gases determined; these partial pressures represent the tensions of the same gases in the blood. The tensions of the gases in the expired air were determined at the same time. In nearly all cases in the blood the carbon dioxide tension was found lower, the oxygen tension higher, than in the expired air. The results would have been still more striking, could the air of the pulmonary alveoli have been used, since there the CO_2 tension is necessarily greater, the O tension less, than in the expired air. The experiments indicate that each gas, in passing through the alveolar and capillary walls passes from a place of low to one of high tension, a fact which

[1] *Centralblatt f. Physiologie*, 1887, p. 293, and 1888, p. 437.

is inexplicable on the hypothesis of diffusion. The author ascribes to the lung tissue a distinct secretory power for both O and CO_2, a quality which is possessed by the swim-bladder of fishes.

DR. H. P. BOWDITCH'S "Hints for Teachers of Physiology"[1] is an admirable little book, intended for the use of teachers in grammar schools and upward. It contains numerous suggestions of methods by which text-book instruction may be supplemented by "simple observations and experiments on living bodies or on organic material, thus imparting to pupils a knowledge of the foundation on which physiology rests, and, at the same time, bringing the impressions made on the senses to aid the memory in retaining the facts communicated in a purely didactic way." Digestion, circulation, motion, voice, animal heat, respiration, vision, and hearing are treated, but by no means exhaustively, for the author does not attempt a complete treatise on physiology. The hints are so excellent that it is a pity that the work is not more full.

PSYCHOLOGY.

MINOT'S REPORT ON DIAGRAM TESTS.—During the past year a large number of postal cards were distributed, each bearing the printed request: "*Please draw ten diagrams on this card, without receiving any suggestion from any other person, and add your name and address.*"

The committee has received for examination 501 postal cards, with diagrams upon them. A few of the cards had more than ten diagrams upon them, and of such cards only the first ten diagrams on each were counted. A few cards had less than ten diagrams.

The cards were divided into three sets; 1, men; 2, women; 3, without names. Each set of cards was numbered, and the diagrams on each card numbered.

Such tests as the diagrams, on which this report is based, demonstrate the slightness of our real individual distinction and separation. The similarity is so great that the same visual images arise in many of us with approximately the same readiness.

We come here to a domain of psychology which has been but little and inadequately studied, namely, the frequency

[1] "Guides for Science Teaching," No. 14, pp. 58, Boston, D. C. Heath & Co., 1889.

and the readiness with which ideas recur. In a previous report in the Proceedings (*ante*, pp. 86) I have shown that even in so indifferent a matter as the ten digits, there are unconscious preferences of the mind, or, in other words, that the notions or images of certain digits come forward oftener and more readily than of others ; and I have also shown *ante*, pp. 90-91, that the order of relative frequency is similar for different persons. It is probable that all ideas possess each its special degree of readiness of appearing in consciousness, and that the degree of readiness is approximately the same for a great many persons. This similarity probably also prevails in regard to the majority of ideas.

This aspect of our mental processes puts the problem of thought-transference in a somewhat different light from that in which we have been asked to view it. It is evident that if two people are requested to think of some one thing as a class, such as a letter of the alphabet, a playing card, a baptismal name, there is by no means an equal chance of their selecting any one ; on the contrary, there is not only the probability that they will think of a special one first, but there is a chance of their both thinking of the same one, for the relative frequency or preponderance of one idea or image out of a set has been shown to be similar for a number of people. In order to prove the reality of thought-transference, it must be demonstrated that the observed coincidence of thoughts can *not* be explained by the law of relative frequency.—*From Proceedings of the Society of Psychical Research.*

MICROSCOPY.[1]

THE CULTURE OF INFUSORIA.[2]—*Damp chambers.* The first requisite in the culture of infusoria is suitable damp chambers, constructed with a view to reducing the evaporation of the water of the preparations to a minimum. Evidently, bell-jars, admitting a large volume of air, will not serve the purpose. Low, flat-bottomed dishes, with vertical sides, and about 20 cm. in diameter, are recommended. The dish is partly filled with fine, well-washed sand, and in this are planted longitudinally two upright strips of glass, of such a height that the superior edge is 4 or 5 mm. below the level of the edge of the dish.

On these upright pieces as supports are placed three others,

[1] Edited by C. O. Whitman, Director of the Lake Laboratory, Milwaukee.

[2] E. Maupas. La Multiplication des Infusoires ciliés. *Arch. de Zool. Expér. et Gen.* xvi., no. 2, 1888, p. 179.

the middle one having a width of 4-5 cm., the two others 2 cm. only. It is on these three slips that are placed the object slides bearing the infusoria. The whole is covered by a glass plate, fitted as hermetically as possible to the edge of the dish. The dish being filled with rain water up to the horizontal strips, the air space is reduced to a layer of 4 or 5 mm. in thickness. This layer of air is always saturated with moisture, and the preparations suffer only an extremely feeble evaporation.

For sorting and transporting infusoria, glass pipettes, about 10 cm. long, are used. The tapering end should be thin, and its opening not over 1 mm. in diameter. The infusoria are first placed *en masse* in a large drop of water upon a slide, and examined with a low magnifying power. The inside of the pipette is wet by filling it once with water. An infusorian having been selected under the microscope, the mouth of the pipette is placed near that side of the drop of water where the infusorian is found. As soon as the pipette touches the drop, a portion of it is drawn in by capillary attraction, carrying with it the specimen sought, together with, perhaps, others not wanted. The contents of the pipette are expelled upon a second slide. If the drop contain several infusoria, a drop of rain water is added, and the manœuvre with the pipette repeated. In this way the isolation of an infusorian may be surely and rapidly accomplished. After each operation with the pipette, it should be washed with care, by forcing fresh water through it several times. Some infusoria have a strong adhesive power, and it often happens that they are left adhering to the internal surface of the tube; hence the importance of washing after each experiment.

The isolated individual is covered with an ordinary cover-slip, preferably one 18 mm. square. The cover-slip may be supported by small pieces of bristles from a tooth-brush. As these pieces have a mean thickness of about .3 mm., it follows that the space inclosed represents a volume of about 100 cu. mm., and will hold 10 cg. of water, or about 5 drops. The entire space should be filled with water. It is very important in such work to use pipettes, slides, and slips that are perfectly clean. The least trace of a reagent left on the cover-slip may be enough to render the whole preparation valueless.

Infusoria thus inclosed and protected may live indefinately under perfectly healthful conditions. Supplied with proper food, they will develop and multiply with all the energy of their highest power of reproduction.

Supply of food. In order to supply carnivorous species easily with food, it is necessary to find among the more com-

mon infusoria a species of small size, that can be readily cultivated.

Cryptochilum nigricans answers perfectly these conditions. It is herbivorous, and occurs everywhere in abundance. In order to utilize it as food for carnivorous species, proceed as follows :—Prepare an infusion by cutting up a few pinches of hay in water, and heat the same for a few minutes to a temperature of 60° C. for the purpose of destroying strange species. Allow the infusion to stand two, three, or four days, according to temperature, until Schizomycetes have developed in it ; then sow some Cryptochila in it, taking care not to introduce other species at the same time. The vessel containing the infusion should always be covered with a closely-fitted plate of glass. The Cryptochila, finding abundance of food in the Schizomycetes, thrive and multiply by myriads. When the culture begins to decline—as it always will in regular course—it can be revived two or three times by adding crumbs of bread in small quantity. Too much bread causes acid fermentation which destroys the infusoria. Instead of hay, pepper might be employed for these infusions, but it would be necessary to determine by experiment the quantity that could be safely mixed with a given volume of water. Too large quantities have been found to give infusions that checked the development of the infusoria.

Having thus obtained a well stocked infusion, the mode of serving the Cryptochila to the carnivorous species isolated in the manner above described, is as follows :—Place a drop of the infusion on a slide, and cover it with a cover-slip. It will then be seen that the Cryptochila collect round the edge of the cover, and in this position they are easily drawn into a pipette, and then delivered over to the carnivorous species. This mode of feeding enables one to make sure that no foreign species is introduced into the culture. Other species would undoubtedly serve the purpose of food as well as Cryptochilum, for example, *Colpidium colpoda*.

In the culture of herbivorous species, Maupas uses boiled flour as food. A pinch of flour is placed in a sufficiently large quantity of rain water, and boiled two or three minutes. With this pap one can easily supply the needs of Paramaecium, Colpidium, Glaucoma, Vorticella, and probably all species that ordinarily feed almost exclusively on Schizomycetes. This food is easily prepared, and is readily served by allowing it to flow in small quantity under the cover-slip of the preparation. It keeps only a short time, and hence must be renewed every day or two.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

UNITED STATES NATIONAL ACADEMY OF SCIENCES.—The annual stated session of the National Academy of Sciences was held in Washington, D. C., beginning Tuesday, April 16, 1889, at 11 A. M.

The following officers were elected to serve for six years: President, O. C. Marsh; Vice-President, S. P. Langley; Home Secretary, Asaph Hall.

Six members of the council of the academy were also chosen, those elected being Gen. F. A. Walker, Boston Mass., formerly Commissioner of the Census Bureau; Gen. M. C. Meigs and Prof. Simon Newcomb, of Washington; Prof. Ira Remsen, of Johns Hopkins University, Baltimore, Md.; Prof. G. J. Brush, New Haven, Conn., and Dr. B. A. Gould, Cambridge, Mass.

New members of the academy were elected as follows: Prof. Sereno Watson, botanist, Cambridge, Mass.; Prof. Lewis Boss, director Dudley Observatory, Albany, N. Y.; Prof. C. S. Hastings, physics, Sheffield Scientific School, New Haven, Conn.; Prof. Arthur Michael, chemist, College Hill, Mass., Dr. C. A. White, United States Geological Survey.

The following papers were read:

On Composite Coronagraphy,[2] D. P. Todd, introduced by S. Newcomb; Notice on the Method and Results of a Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals,[1] Wolcott Gibbs and Hobart Hare; On Sensations of Color,[1] C. S. Pierce; Determinations of Gravity, C. S. Pierce; On the Pliocene Vertebrate Fauna of Western North America,[1] E. D. Cope; On the North American Proboscidia,[2] E. D. Cope; On the Mass of Saturn,[3] A. Hall, Jr., introduced by G. J. Brush; On the Rate of Reduction of Nitro-compounds,[3] Ira Remsen; On Some Connection Between Taste and Chemical Composition,[3] Ira Remsen; Recent Researches in Atmospheric Electricity,[3] T. C. Mendenhall; Measurement by Light Waves,[3] A. A. Michelson; On the Feasibility of the Establishment of a Light-wave as the Ultimate Standard of Length,[4] A. A. Michelson and E. W. Morley; On the General Laws pertaining to Stellar Variation,[4] S. C. Chandler; Review of the Trivial Names in Piazzi's Star Catalogue,[4] C. H.

[1] Read April 16.
[2] Read April 17.
[3] Read April 18.
[4] Read April 19.

F. Peters; On Cretaceous Flora of North America,[1] J. S. Newberry; Spectrum Photography in the Ultra-Violet,[1] Romyn Hitchcock, introduced by A. Hall; The Plane of Demarcation between the Cambrian and Precambrian Rocks,[1] C. D. Walcott, introduced by R. Pumpelly; Report of the American Eclipse Expedition to Japan, 1887,[1] D. P. Todd, presented by S. Newcomb.

BOSTON SOCIETY OF NATURAL HISTORY, Jan. 2, 1889.—Rev. John J. Gulick of Japan read a paper on "Lessons in the Theory of Divergent Evolution, Drawn from the Distribution of the Land Shells of the Sandwich Islands." Dr. Gulick illustrated his talk with specimens of shells from the island of Oahu, and drew several conclusions therefrom. He showed varieties to be but incipient species, and species but special varieties, and stated that divergent evolution does not necessarily depend upon environment. He also stated that areas of distribution vary directly as the power of migration, and in closely allied groups the degree of divergence is measured by the geographical separation. At the close of this paper, Dr. Gulick's ideas were discussed by the members of the society, Professor Hyatt speaking at some length. Dr. D. F. Lincoln then described the "Surface Geology of the Middlesex Fells," illustrating his talk with map drawings and specimens of rocks from the region, after which Mr. J. Walter Fewkes spoke shortly of the significance of the so-called "Fossil Palms" and similar rock formations of the Bermuda Islands. Feb. 21, 1889.—Last November, in connection with work on the Boston, Revere Beach & Lynn railroad, some Indian graves were discovered near Winthrop Centre, and Prof. F. W. Putnam gave the results of his discoveries in the place. He showed lantern views of seven skeletons which were unearthed, together with pictures of weapons, pottery, and shell beads found in the graves. All of the skeletons were found within a small area, and all of them buried in the same positions, their faces toward the east. In all the graves many shells were present.

Mr. H. G. Woodward gave a general description of the geology of Brighton, and the surrounding vicinity, and showed specimens of rocks illustrating the geological peculiarities of the place.

[1] Read April 19.

SCIENTIFIC NEWS.

From 1885 to 1888 the regretted Professor Cienkowsky practised (in Russia) 20,310 vaccinations against *charbon* in sheep. The average loss was 0.87 per 100. In a flock of 11,000 sheep, the ordinary mortality among which was 8.5 to 10.6, the mortality after inoculation fell to 0.13 per 100. In another case, thirteen months after the preventive inoculation, 18 sheep out of 20 resisted the action of virulent charbon.

At the international exhibition of geographical, commercial, and industrial botany, which will be held at Antwerp, in 1890, the third centenary of the invention of the microscope will be celebrated. The exposition will illustrate the past history of the microscope and its present state by means of microscopes and microscopical appurtenances of past and present times, as well as by photo-electrical microscopical exhibitions showing the history and uses of the microscope, animal and vegetable structure, and adulterations of food, etc., etc. These exhibitions will continue during the entire period of the Exposition.

The next meeting of the British Association for the Advancement of the Sciences will be held at Newcastle, (England), from September 11th to 18th.

A Congress of Zoölogists will be held in Paris during the Exposition, in the month of August. Among the patrons as announced, appear the names of men of all nations.

On the shores of Lake Issik-Kul in Central Asia a monument is to be erected to the explorer Prjevalsky, after a design by Bilderling, his comrade. According to the *Invalide Russe* "the monument represents a picturesque rock 28 feet high, on the top of which is perched a large eagle, emblem of strength, intrepidity, and intelligence. The eagle grasps in its talons a map of Central Asia, the arena of the scientific exploits of the deceased, and in its beak an olive branch, symbol of the peaceful scientific conquests which Russia owes to Prjevalsky. On one side of the rock is a large bronze cross, between which is the inscription, 'Nicholas Mikhailovitch Prjevalsky, born 29th of March, 1839, died 20th of October, 1888.' In the interior of the rock is cut a spiral staircase crowned with an enlarged copy of the medal struck by the Academy of Sciences in 1887 in honor of Prjevalsky, and showing the original inscription: 'To the first explorer of Nature in Central Asia.'"